# Exploring the Effects of Learning Style on the Use of an Electronic Library System

**Joanna J Worth**

A thesis presented to

**DE MONTFORT UNIVERSITY**

in partial fulfilment of the requirements for the Degree of Doctor of Philosophy

March 1999

# ABSTRACT

Electronic library systems (ELS) are becoming increasingly employed within higher education institutions as they ease the pressure on resources and improve the quality of, and access to, information services. In order to work effectively, ELS must satisfy the needs and preferences of users. As large differences in the user population often give rise to differing requirements, an understanding of the needs associated with different characteristics is essential. Differences in learning style are considered particularly influential in the design of information systems. Therefore, an understanding of the relationship between learning style and information retrieval is essential to the design of effective ELS.

Previous research regarding learning style and information retrieval has not focused specifically on ELS and does not provide an adequate base on which to build research within the ELS environment. The research described in this thesis provides the foundation on which to build understanding of the impact of individual differences on information retrieval from ELS.

The research investigates whether learning style influences patterns of information retrieval from ELINOR (an example ELS) over a range of tasks. The ability of ELINOR's functionality to support the information retrieval activities associated with different learning styles is also examined. The approach taken in answering these research questions is quantitative. A logging system was employed in gathering statistical data regarding patterns of information retrieval. Patterns were observed in terms of the number and nature of documents and operational facilities used by learning style groups when undertaking simple and complex tasks. Questionnaires were employed in ascertaining the learning styles, demographic characteristics and attitudes towards ELINOR of a sample of students. Hypotheses regarding the information retrieval patterns associated with different learning styles and ELINOR's ability to support the information retrieval activities of different learning style groups are proposed and investigated by examining relevant summaries of data. Confidence intervals were employed in making inferences about the information retrieval behaviour associated with different learning style groups. However, the methodology also includes more qualitative methods of inquiry in the form of interviews to aid interpretation of the statistical data gained from the evaluation questionnaire and assess the suitability of the research methodology.

Use of ELINOR as an example ELS is highly appropriate within this research. ELINOR's content comprises the full-text of documents rather than, for example, photographs. A major aim of ELS is to reduce the need for libraries to store physical documents. As the majority of documents academic libraries are required to hold are text-based, the majority of ELS developed are also likely to be text-based. The major aspects of ELINOR's functionality are also representative of those employed by many text-based information retrieval systems, other than ELS. The majority of systems incorporate functions similar to ELINOR's Search facility whereby the text within documents is matched to a query supplied by the user. Other information retrieval systems, such as those based on Hypertext or Hypermedia, may also employ facilities similar to ELINOR's Fileroom facility. The Fileroom provides a more structured approach to information gathering, allowing documents to be located through a series of menus relating to subject or document type. Therefore, the findings may be applied to a wide variety of information retrieval systems.

Findings from the research reported in this thesis indicate that learning style has little influence on patterns of information retrieval from ELINOR. However, a possible relationship was found between learning style and the use of ELINOR's Search and Fileroom facilities for one of the simple tasks. For this task Activists and Pragmatists preferred to use the Search facility whilst Reflectors and Theorists preferred the Fileroom. Findings also indicate that ELINOR's functionality cannot support the information retrieval activities of different learning style groups. ELINOR's document content is insufficient for successful completion of both simple and complex tasks by all learning style groups. All groups were constrained by ELINOR's operational facilities for both types of task with the exception of Pragmatists who found them sufficient for completing simple tasks.

The research indicates that learning style requires consideration when designing ELS and prescribes the functionality necessary to enhance the effectiveness of ELS in meeting the requirements of different learning style groups. The findings may also be applied to the design of any information retrieval system which comprises the full-text of documents.

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# ACKNOWLEGEMENTS

I would like to thank my Director of Studies, Dr. Chris Fidler, whose guidance and encouragement throughout this research are especially appreciated in view of her recent illness.

I am also grateful to Professor Derek Teather, Professor Jo Haythornthwaite, Dave Rowley, Nick Longford and Bob John for their help and direction.

Many thanks and appreciation for the co-operation and active involvement of all the students who participated in the research, the completion of which would not have been possible without their assistance.

I would also like to acknowledge the ELINOR project team for their co-operation during the period of practical research.

Finally, I am grateful to my family and friends for their enduring patience and support.

# CHAPTER 1

## INTRODUCTION

Facilities for electronic information retrieval are increasing within higher education institutions. This is largely a result of conclusions emerging from the Follett Report (1993). The Follett Report concludes an investigation concerning the way in which higher education institutions may deal with the pressures on library resources which are resulting from rising student numbers and a rapid increase in academic knowledge and information.

It is desirable that any information retrieval system is easy to use, regardless of the knowledge held of, or the skill in using the system. These systems should also satisfy the information needs of the user population in terms of content. Individual differences between users of information retrieval systems may lead to differing preferences and requirements regarding their design (Logan, 1990; Hsieh-Yee, 1993). Therefore, in order for information retrieval systems to be effective in meeting the needs of target users, designers must achieve a thorough understanding of users and their diversity. This fact has been widely recognised by writers, such as Shneiderman (1987).

Different types of information retrieval system include CD ROM, on-line databases and Electronic Library Systems (ELS). An ELS may be defined as:

> *"a system designed for the provision and management of information for the purposes of teaching, learning and research in which the full content of materials are held in electronic form; its adaptability and cost-effectiveness allowing the needs of individual institutions to be to met effectively."* (Worth and Fidler, 1997).

Differences in learning style are considered particularly influential in the design of information systems, including ELS. Previous research into differences in learning style has not focused specifically on ELS. For example, research has attempted to correlate learning style with measures of searcher behaviour using other types of information retrieval system such as CD

ROM (Balaraman, 1991) and on-line databases (Saracevic et. al., 1988). However, they do not provide an adequate base upon which to build research within the ELS environment when considering learning style and information retrieval behaviour. This research provides the foundation on which to build understanding of the impact of individual differences on information retrieval from one ELS: ELINOR. ELINOR is an acronym for Electronic Library INformation On-line Retrieval. The ELINOR system was developed at De Montfort University (Wu, Ramsden and Zhao, 1995).

The research focuses on the process or patterns of retrieval associated with user groups with differing learning styles when performing a range of tasks. Thus it is the method by which users access information which is primarily being examined. This is considered by the author to be of greater benefit to the design of effective systems than measures such as precision and recall which have typically been used to determine system performance (Hsieh-Yee, 1993). The research not only examines whether students can retrieve the information they desire, but also whether ELINOR can support the user's preferred method of retrieval. The research targets those who are most likely to use ELS (i.e. students) for the research sample. This is important if the results are to be of relevance to the higher education community. The two major research questions addressed within this thesis are stated as follows.

> *Does learning style influence patterns of information retrieval from ELINOR for simple and complex tasks?*
>
> *Can ELINOR's functionality support the information retrieval activities of different learning style groups for simple and complex tasks?*

The research may indicate that learning style requires consideration in the design of future ELS. In this instance the findings may assist in prescribing the functionality necessary within ELINOR (or indeed any ELS of similar description) to support the patterns of information retrieval associated with each learning style over the range of tasks included within this research. This will aid in designing ELS which are more effective in meeting the requirements of target users. Alternatively, the findings may suggest that learning style does not require consideration when designing ELS.

The structure of this thesis is as follows.

Chapter 2 provides an overview of ELS, highlighting the reasons for their development and increasing employment, and compares the relative merits of ELS with respect to other types of information retrieval system. The aims, objectives and functionality of an example ELS: ELINOR are also given.

The concept of learning style is explained in Chapter 3. An insight into the variety of ways in which the concept has been defined is provided and various approaches for identifying and measuring an individual's learning style described.

A review of the literature regarding previous research into learning style and information retrieval is given in Chapter 4. The extent to which conclusions from previous research are of value to researching the relationship between learning style and information retrieval from ELS is also assessed.

Building on the literature review in Chapters 2, 3 and 4, Chapter 5 summarises the issues raised and provides a statement of the aims and objectives of the present research.

The research methodology is discussed in Chapter 6. The approach taken is quantitative and uses questionnaires and a logging system in gathering statistical data regarding learning styles, demographic characteristics, attitudes and patterns of information retrieval. However, interviews were also employed in gaining more qualitative data to aid interpretation of the data gained from the evaluation questionnaire and assess the suitability of the research methodology.

A number of decisions were made regarding the treatment of data from the logging system and evaluation questionnaire. These decisions were required in order to ensure an accurate representation of the patterns of information retrieval and attitudes held towards ELINOR. Chapter 7 details the nature of these decisions.

Chapter 8 focuses on the detailed analysis of the data gained and findings from the investigation. Finally, Chapter 9 provides a summary of what has been achieved within this research and identifies important issues for further research.

# CHAPTER 2

## THE ELECTRONIC LIBRARY

This chapter provides an overview of the electronic library concept. Specifically, Section 2.1 compares and contrasts various definitions of the electronic library and emphasises the importance of electronic libraries to higher education. Sections 2.2 and 2.3 detail the aims, objectives and functionality of an example Electronic Library System (ELS): ELINOR. Section 2.4 compares the relative merits of ELS with various other electronic information retrieval systems. Finally the significance of individual differences to the design of effective ELS is discussed in Section 2.5.

### 2.1 Defining The Electronic Library Concept

Several alternative terms have been applied in describing the electronic library including "digital library" and "virtual library" (Cook, 1997). Relevant literature does not suggest a generally accepted distinction between the terms electronic library and virtual library. However, Collier et al. (1993) suggest a differentiation may be made based on the following concepts. Academic libraries are generally automated libraries, utilising technology to manage routine transactions such as acquisitions, cataloguing and issuing (Wu et al., 1993). These libraries often employ electronic facilities for information retrieval such as OPAC (On-line Public Access Catalogue) and CD ROM in addition to printed material. Collier et al. (1993) suggest that automated libraries may reach their ultimate form, continuing to comprise study space and people but with wholly electronic facilities for accessing information and collections. Thus, automated libraries may eventually become electronic libraries in the sense that no printed material will be held. Therefore, the electronic library will continue to operate within the confines of a physical location. The term virtual library, by contrast, suggests a concept where no physical location is required for accessing the library's content. Regarding the virtual library, Collier et al. (1993) state:

> *"the searcher may think he/she is retrieving information from a local source but in fact it is flowing imperceptibly and instantaneously from all the corners of the world."* (p. 139).

Wu et al. (1993) provide an alternative viewpoint, suggesting that the concept of the electronic library extends that of automated libraries in two significant aspects:

> *"Firstly, the printed book collection is replaced by multimedia databases (paperless). Secondly, the use of library resources is no longer restricted to the physical locations of libraries because of networking technologies (without walls)."* (p. 2).

This second point is clearly a feature of the virtual library as defined by Collier et al. (1993). Thus, differing viewpoints are held by Collier et al. (1993) and Wu et al. (1993) regarding the nature and scope of the electronic library and virtual library.

The International Institute of Electronic Library Research (IIELR) at De Montfort University provide the following definition for the electronic library:

> *"... an organised and managed collection of mixed media materials in digital form designed for the benefit of a particular user population, structured to facilitate access to its contents and equipped with aids to navigation of the global information network".* (http://www.iielr.dmu.ac.uk/Documents/defin.htm).

This definition is sufficiently loose to bear consistency with either of the definitions provided by Collier et al. (1993) or Wu et al. (1993). No indication is given as to the requirement for a physical location for the electronic library.

The term digital library is often used in the US to describe the electronic library (Cook, 1997). Nagao (1995) proposes four significant aspects of a digital library: the ability to retrieve information regarding multiple units of books and journals, for example, individual papers or articles held within a single document; the ability to create links between related information; the ability to provide a variety of functions for reading a book, such as changing the text format and font size and; the ability to connect digital libraries to one another through a network, achieving the impression of a single library system. This description suggests that the digital library has features of the virtual library, as defined by Collier et al. (1993) and of the electronic library, as defined by Wu et al. (1993).

Barker (1994, 1996) provides a taxonomy of library developments distinguishing between electronic, digital and virtual libraries. Barker defines the electronic library as a system in which *"the core processes of a library system become basically electronic in nature"*. (p. 495, 1996). Electronic media is used to provide facilities such as on-line indexes, full-text searching and retrieval, automated record keeping and computer-based decision-making. Barker also incorporates into his definition the element of computerising routine queries usually dealt with by library staff, although he stresses that librarians will still be required to give assistance with other library matters. Barker's definition of the digital library encompasses a library which holds no printed book stock. Instead materials such as books, journals and newspapers exist in digital electronic format which may be accessed from a computer. As the digital library has the ability to be accessed remotely, the traditional services provided by librarians are complemented with alternative means of gaining access to librarian expertise through use of electronic mail or expert systems. Barker's image of the virtual library is one in which virtual reality technology is used to provide the ability to browse around a representation of a physical library. In addition to providing access to virtual documents, the virtual library may also provide access to virtual librarians and the ability to experience various learning situations.

The definitions provided above illustrate a lack of consensus in the views of researchers regarding the similarities and differences between the electronic, digital and virtual library. However, the principal benefits of each type of library lie in reducing the need for printed book stock and providing electronic facilities which incorporate sophisticated techniques for information retrieval. The provision of library services to a wider user community will be facilitated as the library may be accessed remotely through a network. Librarian services may also be provided electronically.

Interest in the electronic library concept, however it is defined, is increasing as higher education institutions face increasing pressure on library resources from rising student numbers and limited library budgets. In light of these pressures, together with developments in the organisation and funding of higher education and in teaching and learning techniques, the UK Higher Education Funding Councils, chaired by Sir Brian Follett, commissioned the Libraries Review. The purpose of the Review was to consider: the planned expansion of higher education; the current and potential impact of information technology on information provision and; the possibilities of greater co-operation and sharing of capital and resources. The Review also aimed to investigate the future national needs for the development of library and information resources and to identify ways to meet these needs (Follett Report, 1993). In response to the Libraries Review, the Joint Information Systems Committee (JISC) established the Electronic Libraries Programme (eLib), the aim of which is to *"engage the Higher Education community in developing and shaping the implementation of the electronic library."* (http://www.ukoln.ac.uk/services/elib/background/). Other initiatives also exist including Telematics for Libraries (under the EC Libraries Programme) and the US Digital Library Initiative. Various electronic library projects are now being undertaken as a result of these initiatives a number of which are described, briefly, in Appendix A.

The term Electronic Library System may be used to describe innovations developed to assist in the creation of the electronic, digital or virtual library (Ramsden et al. 1994). Within this research, an ELS is defined as:

> *"a system designed for the provision and management of information for the purposes of teaching, learning and research in which the full content of materials are held in electronic form; its adaptability and cost-effectiveness allowing the needs of individual institutions to be to met effectively."* (Worth and Fidler, 1997).

ELINOR (Electronic Library INformation On-line Retrieval) is one example of an ELS. The ELINOR project began development in 1992 as the subject of a research project aiming to build a fully electronic library environment. It is one of the first large scale electronic library projects in the UK, funded by De Montfort University, IBM UK Scientific Centre (Hursley) and the British Library Research and Development Department (BLR&DD). ELINOR was selected as an example ELS for use in the present research. This is discussed further in Section 5.2. Section 2.2 describes the objectives of the project whilst Section 2.3 provides an overview of ELINOR's functionality.

## 2.2 Aims And Objectives Of The ELINOR Project

Ramsden et al. (1994) and Arnold et al. (1993) cite the overall objectives of the ELINOR project as follows.

- To build a large image and text database of books, journals and course materials which can be directly accessed by students and teaching staff via desktop workstations distributed across the various campuses of the University.
- To gain practical experience in the selection, installation and use of an ELS.
- To investigate several aspects to determine the effectiveness of the electronic library: efficient manipulation of images; integration of text with images; text retrieval; high quality interfaces; networking and storage issues; copyright issues; electronic publishing mechanisms; administration; methodology for the evaluation of the system and; future requirements.
- To make licence agreements with copyright owners and to develop usage tracking and, as appropriate, charging mechanisms.
- To research user needs, satisfaction, and to develop training and instruction programmes.
- To design courses and materials around this concept.
- To research the educational benefits of ELS.

A pilot system was built using selected materials from the BA/BSc Business Information Systems degree course. The target users were mainly students undertaking this course and their lecturers. The aim of the pilot system was to: provide an understanding of document conversion and storage requirements; test the usability of the system; establish technical support and user training requirements and; give first hand experience in the staffing and skills required to operate a system serving the whole University.

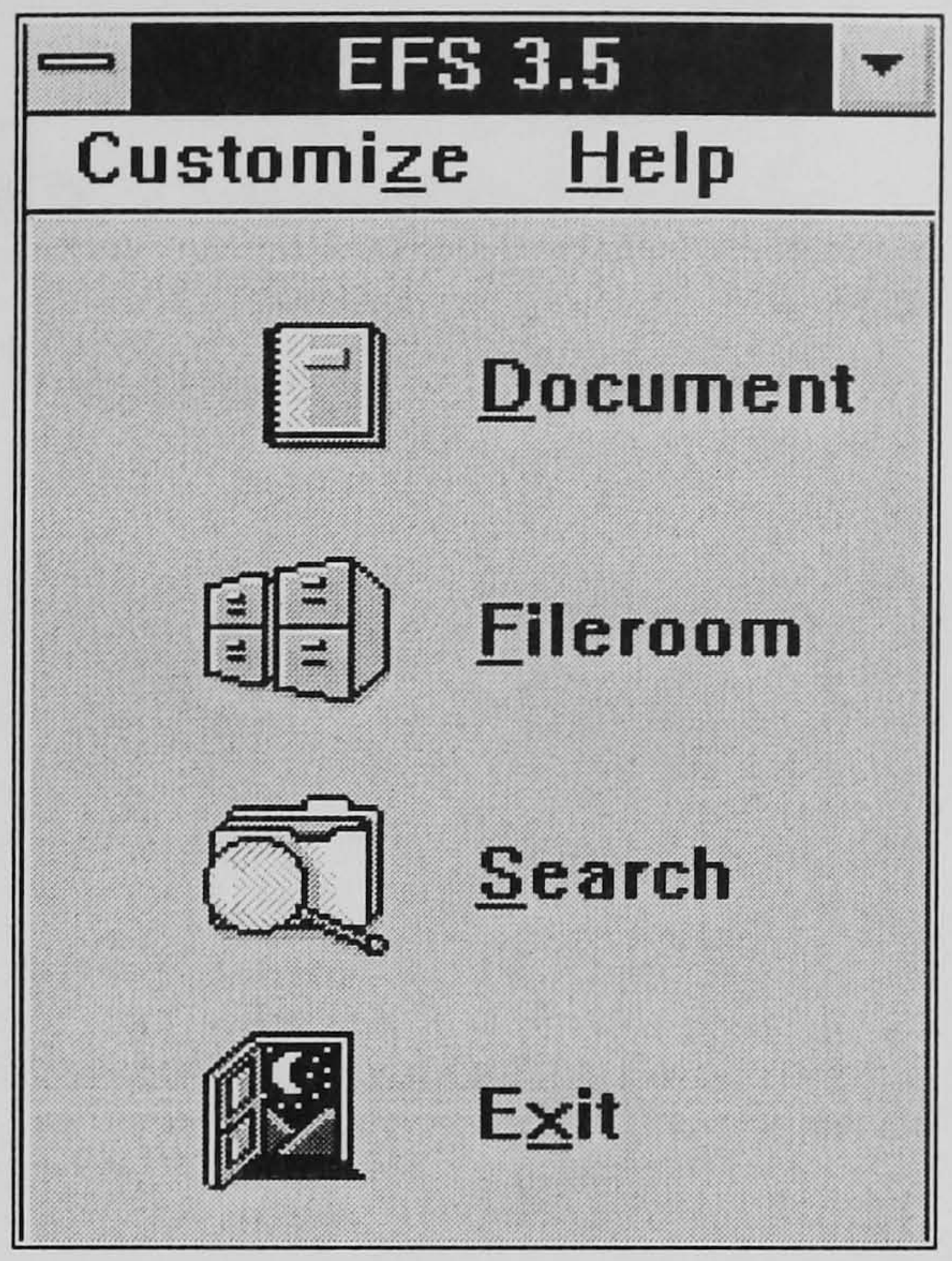
## 2.3 Overview Of ELINOR's Functionality

This section provides a brief overview of ELINOR's design. A more detailed account may be found in the BLR&DD Report (Ramsden et al., 1994).

The computer software selected for ELINOR was Excalibur Technologies' PixTex/EFS (described in Ramsden et al., 1994). PixTex uses a graphical user interface (GUI) based on the WIMP methodology (where WIMP stands for Window, Icon, Mouse, and Pull-down menu). The functionality for browsing, searching and reading the documents contained within ELINOR is described in Sections 2.3.1 to 2.3.5, providing an overview of the type of functionality an ELS may comprise. Browsing may occur when the user requires information on a broad topic area, but has little idea of which documents may contain relevant information. Searching may occur where the user has a more specific requirement for information, for example, where a particular title, or documents by a specific author are required. Many of the facilities provided by ELINOR may be operated by use of either buttons or menus, with the exception of the Text and Image Window facilities which provide menus only. A Help facility is included which may be accessed from any window. ELINOR's functionality allows users to switch easily between different windows. ELINOR also incorporates the facility for printing pages when displayed in the Text and Image Windows. Users may leave each window, with the exception of the Control Window, by selecting the "Dismiss" facility. The Control Window provides an Exit facility which allows users to leave the system. Users cannot leave the Control Window without also leaving the system.

### 2.3.1 Control Window

Figure 2.1
A Representation Of ELINOR's Control Window

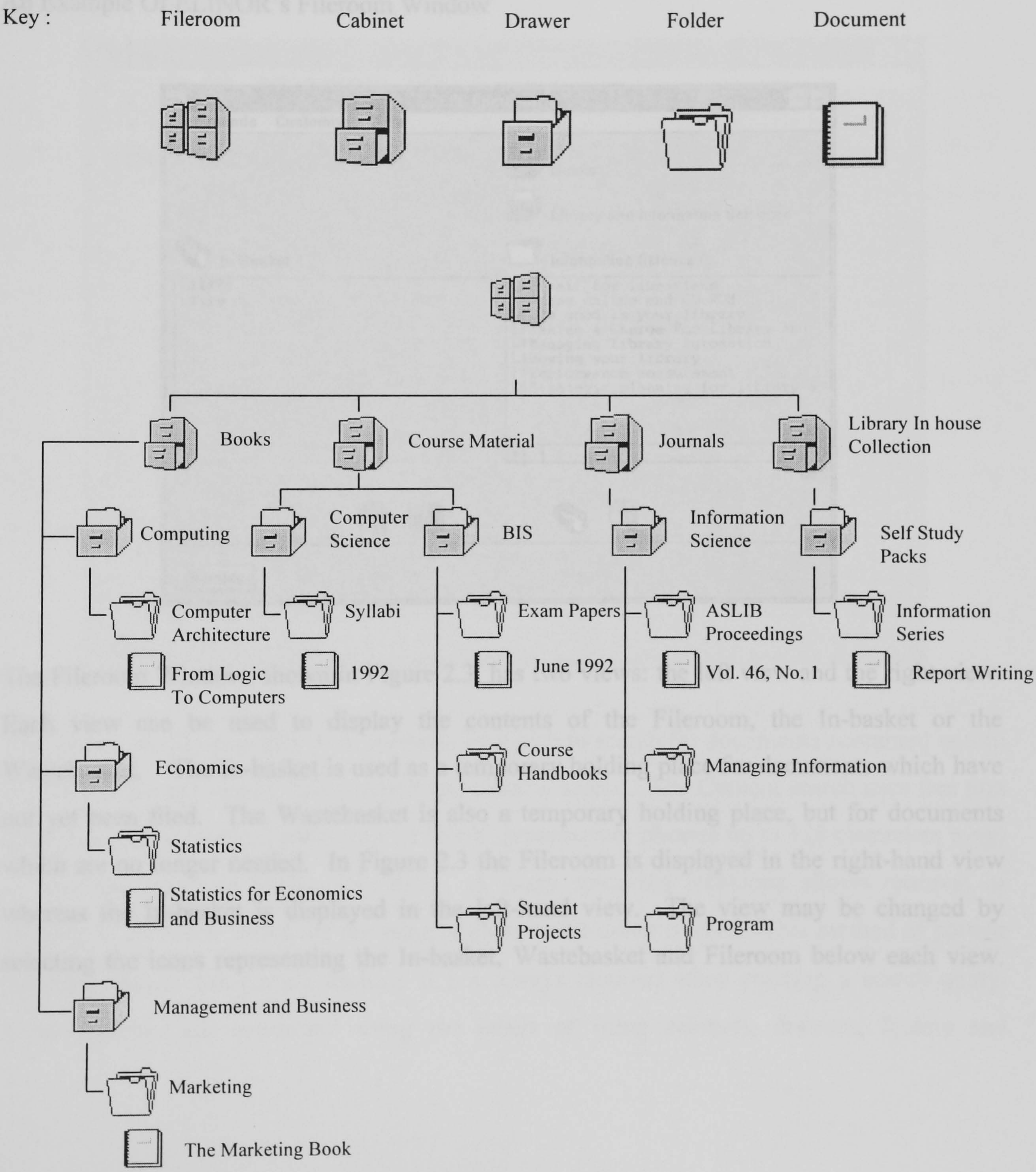



The Control Window, as shown in Figure 2.1, is the initial gateway to ELINOR's document content. Access for both browsing and searching the system is provided through the Fileroom and Search icons. The Document icon allows access to the Document Window. ELINOR provides two versions of the Document Window. Although the two versions appear to be the same, there are differences in the type of access afforded. The first version may be accessed through the Control Window alone and may be used only by the ELINOR project staff for system administration. The second version, for general use, may be accessed through windows other than the Control Window. This version is described in Section 2.3.4.

### 2.3.2 Fileroom Window

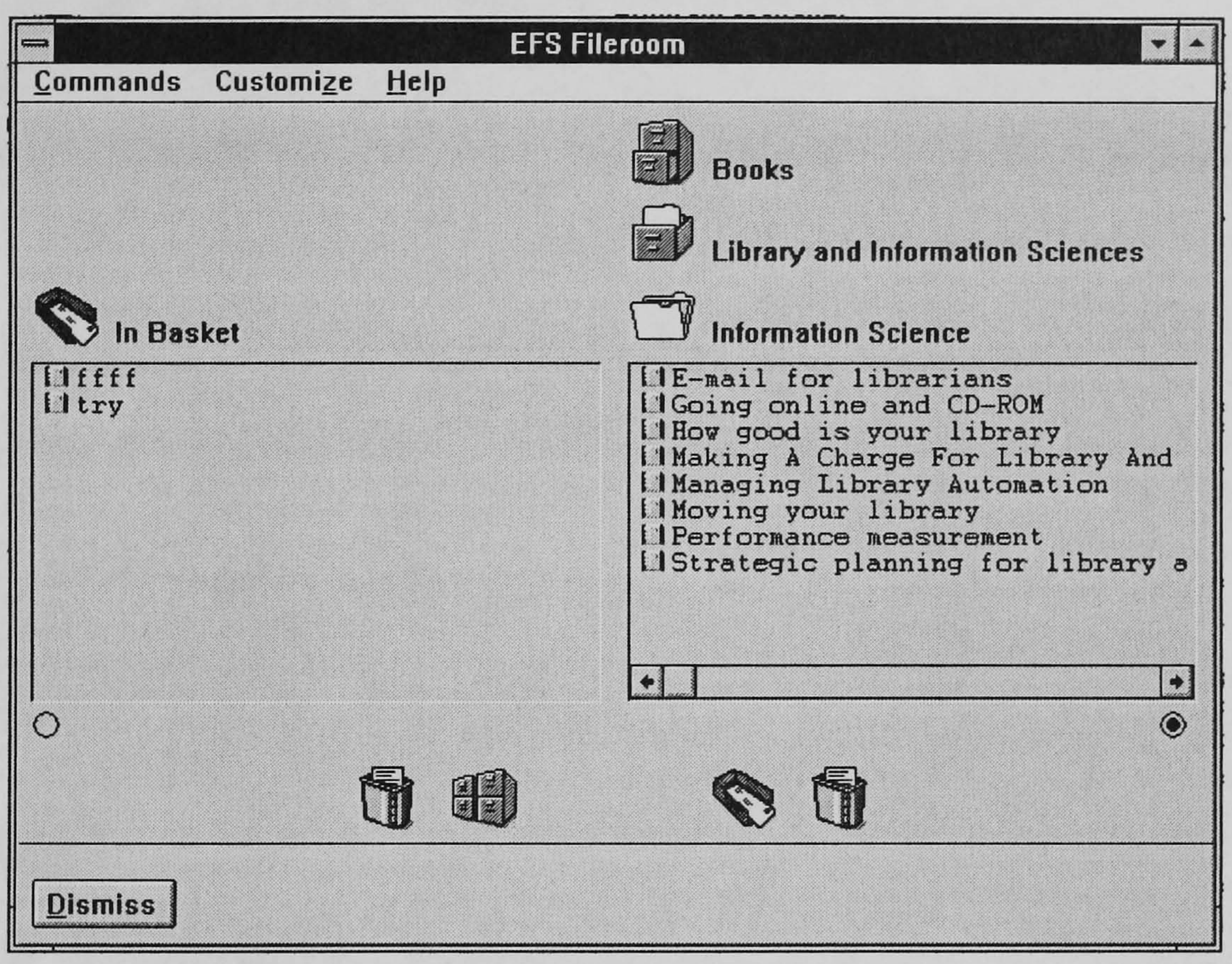
The Fileroom Window represents the hierarchy in which documents are stored in ELINOR's database. The Fileroom allows documents to be located through a series of menus relating to subject or document type. For example, the books cabinet is divided by subject area such as computing or economics. The course material cabinet, by contrast, is divided by the type of material (e.g. exam papers, handbooks). The Fileroom contains one or more filing cabinets; each cabinet contains one or more drawers; each drawer contains one or more folders and folders contain one or more documents. Figure 2.2 shows an example subset of this hierarchy.

Figure 2.2
An Example Subset Of ELINOR's Information Hierarchy



The contents of cabinets, drawers or folders in the Fileroom may be displayed by selecting the appropriate icons. When browsing the Fileroom, ELINOR stacks the appropriate icon for each opened cabinet, drawer and folder above one another, thereby providing a visual aid to navigating the Fileroom. This is shown in Figure 2.3. The user may return to any previous level in the hierarchy by selecting the icon corresponding to the level desired.

Figure 2.3
An Example Of ELINOR's Fileroom Window

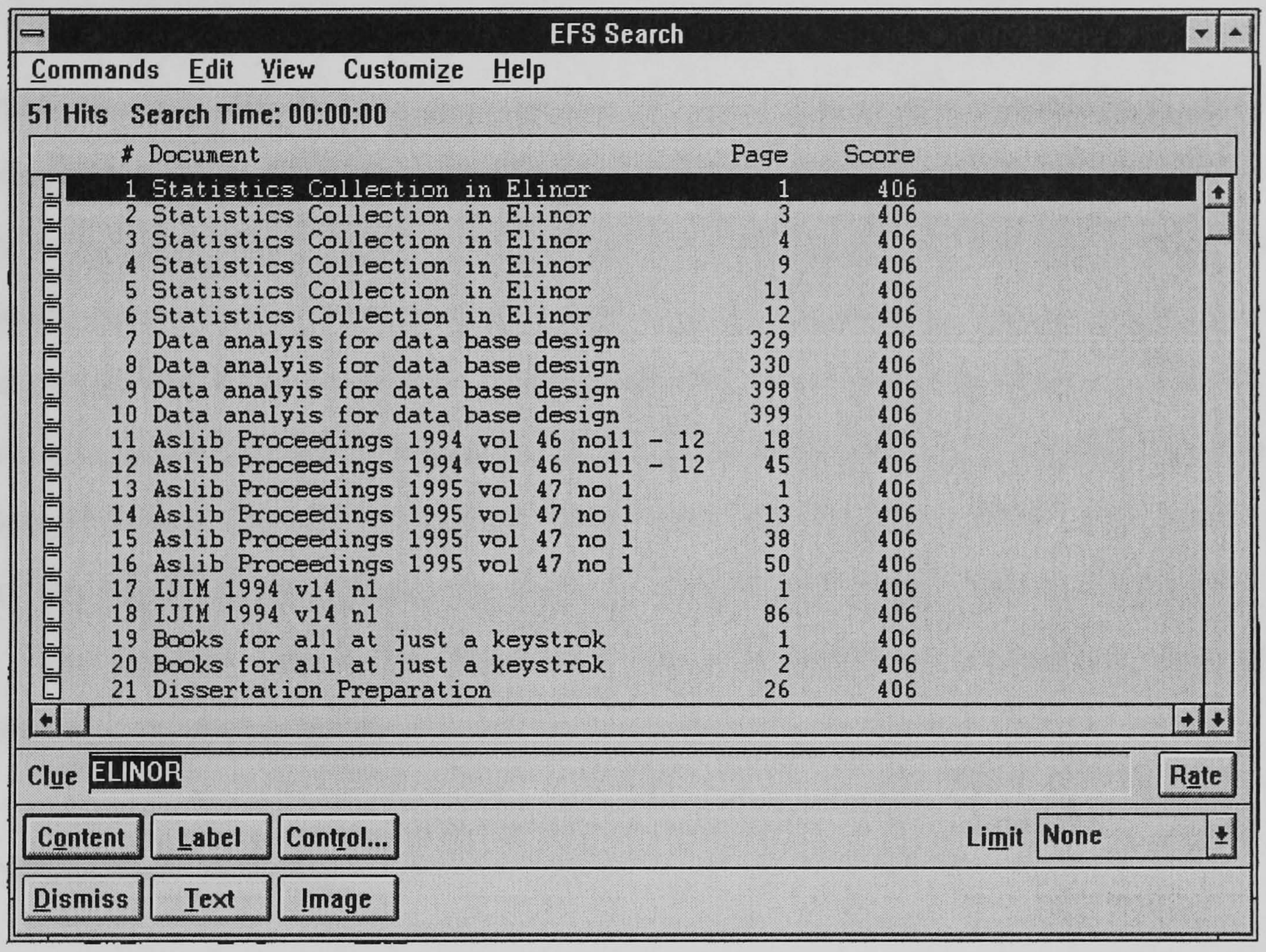



The Fileroom Window, shown in Figure 2.3, has two views: the left view and the right view. Each view can be used to display the contents of the Fileroom, the In-basket or the Wastebasket. The In-basket is used as a temporary holding place for documents which have not yet been filed. The Wastebasket is also a temporary holding place, but for documents which are no longer needed. In Figure 2.3 the Fileroom is displayed in the right-hand view whereas the In-basket is displayed in the left-hand view. The view may be changed by selecting the icons representing the In-basket, Wastebasket and Fileroom below each view.

Users may see where documents have been placed within the Fileroom, but cannot change the filing location.

### 2.3.3 Search Window

Figure 2.4
An Example Of ELINOR's Search Window



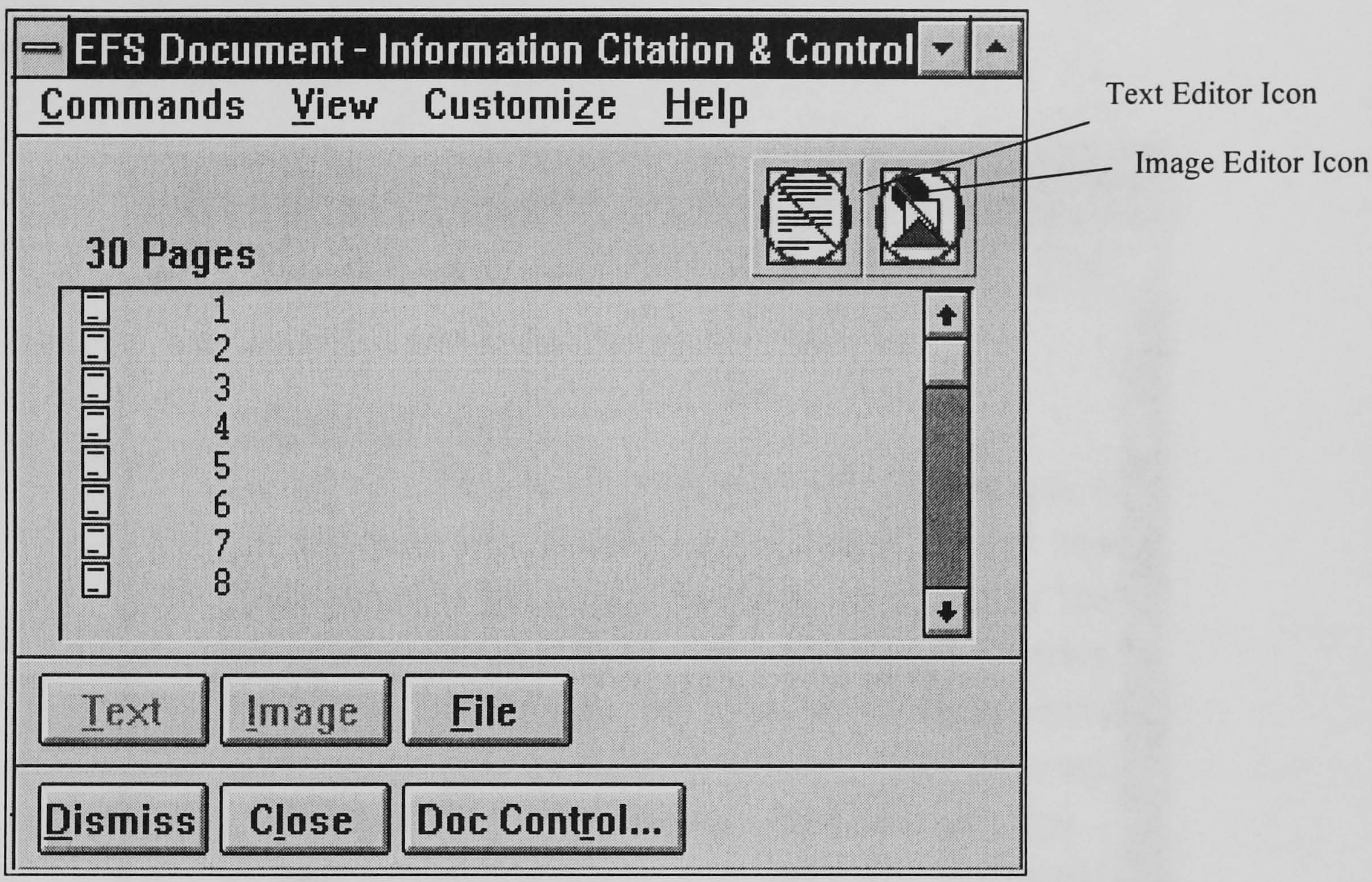

The Search facility provides three methods by which to search for documents contained within ELINOR: Content search, Label search and Control search. The Content search uses free text natural language queries (which can be words, sentences or phrases up to 128 characters long) or Boolean operators (AND, OR, etc.). A fuzzy searching technique allows retrieval of matches to all words which are the same or close to the query entered. This method of pattern matching means that correct spelling is not always required when entering a search query. Label searches are conducted using the labels of filing cabinets, drawers, folders and documents to find matches to the query. The labels of filing cabinets reflect the document type, for example books or journals. Labels of drawers reflect a broad subject category, such as computing, and the folders a secondary subject level, for example, expert systems. Queries for the Content search and Label search may be input into the text field identified by the word "clue". This may be seen in Figure 2.4 where the current query is "ELINOR". The Control search operates using bibliographic information such as an author's name, a title or a publication date. This information is input into a dialog box which appears when the Control search option is selected.

The results of each search are displayed in a hit list which varies according to the type of search employed. The Content search hit list indicates the titles of the documents in which matches to the query were found. Also indicated are the numbers of the pages where matches to the query occur and the number of hits generated by the search. The hit list produced by a Content search can be subsequently rated to provide more accurate results. The degree of relevance can also be adjusted to control the extent to which the query matches the patterns of text. Rated hit lists also contain a piece of text matching the query. The Label search hit list contains the label names of cabinets, drawers, folders and documents corresponding to the query. The Control search hit list gives only the names of documents matching the bibliographic information given.

### 2.3.4 Document Window

The Document Window provides the ability to view the pages of the documents contained within ELINOR. The pages are listed down the left hand side of the window as shown in Figure 2.5. Pages may be viewed in either text or image format through the Text or Image Windows respectively (see Section 2.3.5). Alternatively the text and image pages may be viewed using an appropriate text or image editor (e.g. Microsoft's Notepad™ or JASC's Paint Shop Pro™). These may be accessed by choosing the appropriate options under the "Commands" menu or by selecting the text or image icons indicated in Figure 2.5. The text and image editors provide the facility for annotating the text pages or downloading to diskette diagrams for study purposes. However, any changes made will not affect the content of the documents within ELINOR and must be saved in a separate location. Bibliographic information is also provided though the Document Control facility.

Figure 2.5
An Example Of ELINOR's Document Window




### 2.3.5 Text And Image Windows

The Text and Image Windows, shown in Figures 2.6 and 2.7 respectively, provide views of the pages of documents contained within ELINOR. Copyright issues decree that the majority of pages are presented in image format, preventing readers from downloading the entire text into a text editor. Image pages are created by scanning the actual pages of the document. These pages can be downloaded but rapidly consume the storage capacity of a floppy disk. The software used for scanning the documents creates page numbers in sequence commencing at number one. The documents are therefore scanned beginning with page one so that the page numbers within ELINOR correspond with those in the printed book. However, many documents contain title, contents and preface pages that precede page one. These pages are often differently numbered or unnumbered. Within ELINOR these pages are moved to the back of the document. A separate numbered page is added containing information regarding their location and a diagram of the document's structure.

Figure 2.6
An Example Of ELINOR's Text Window

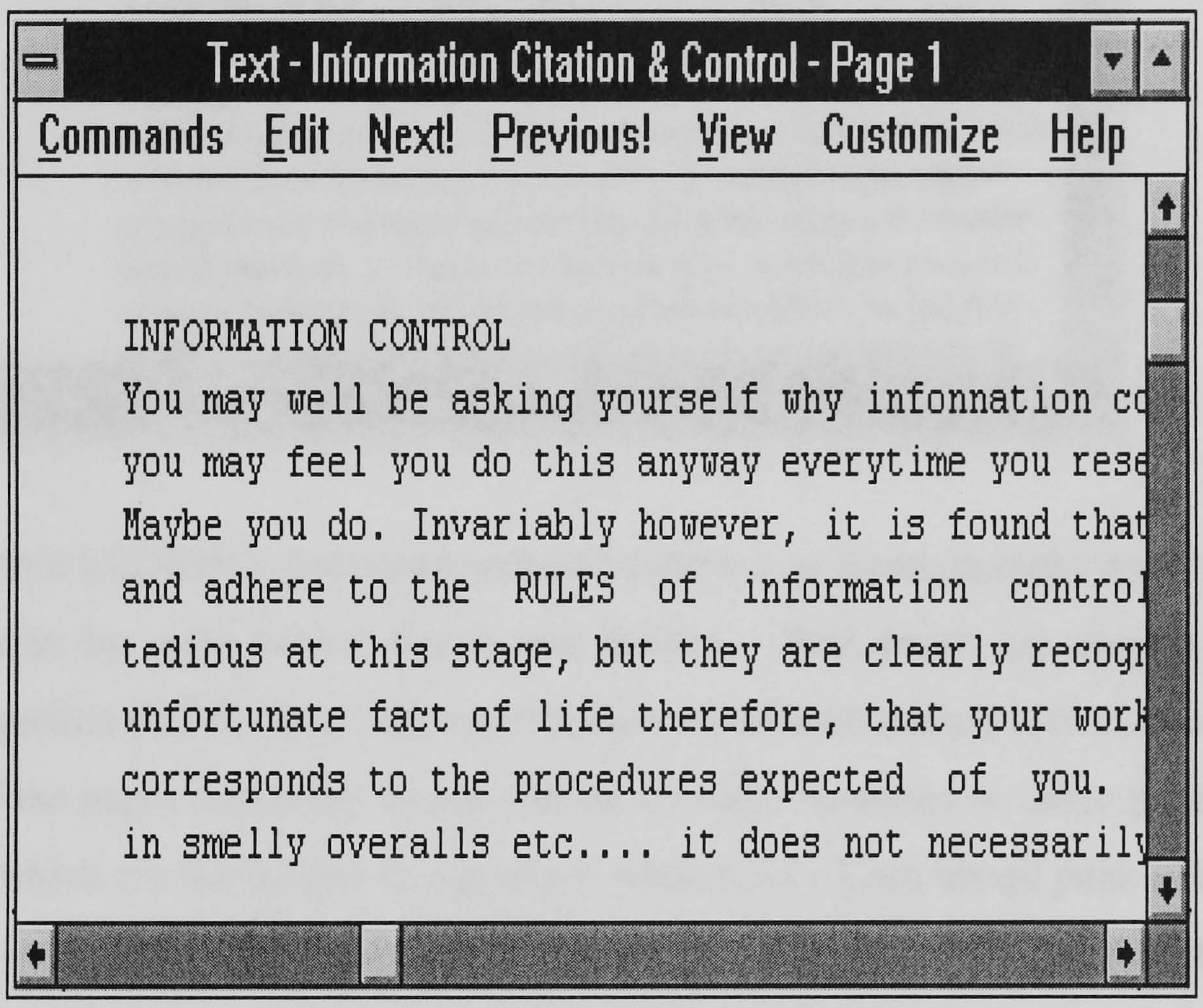
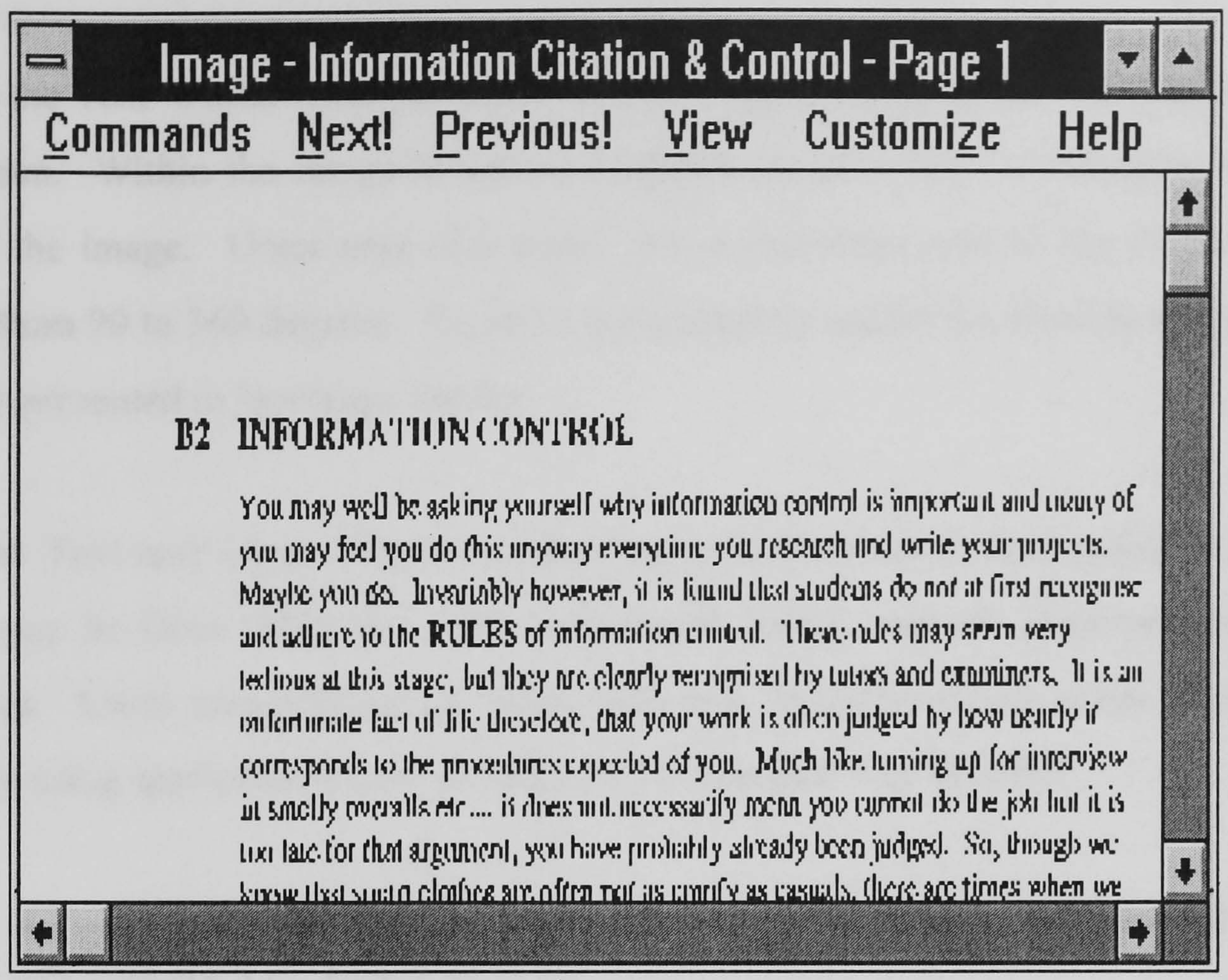


Figure 2.7
An Example Of ELINOR's Image Window




Text pages enable ELINOR's document retrieval software to locate documents in response to the queries given by users within the Search facility. Text pages are created by optical character recognition (OCR) which converts the text of scanned images into machine-readable text. Most of the pages appearing in text format are either contents or index pages, or pages of documents which are not subject to copyright restrictions. Each image page is linked to its corresponding text page (if available, and vice versa) to allow users to switch between them easily. Users can also browse through text and image pages in sequence by using the Next and Previous facilities. Alternatively, the Goto Page option (contained within the Commands Menu of both the Text and Image Windows) allows any page in the document to be selected. However, where the user is currently viewing a text page and the page requested has no corresponding text page, an error message is shown. In this instance the user must view the current page in image format and then use the Goto Page option in the Image Window to reach the desired page. The Next and Previous facilities give an alternative option of viewing the next available text page.

Within the Text Window the tab width and font size may be altered for ease of reading from the screen. Within the Image Window, facilities are provided for enlarging or reducing the size of the image. Users may also zoom into a particular area of the display or rotate the image from 90 to 360 degrees. Rotation is particularly useful for viewing diagrams which are initially presented in landscape format.

Both the Text and Image Windows allow users to view up to four pages at a time. These pages may be from either the same or different books, and are displayed in four different windows. Users may also create notes with any Windows-based editor while viewing the book by using applications such as Microsoft's Notepad™ or Word™.

### 2.4 A Comparison Of ELS And Other Electronic Information Retrieval Systems: Advantages And Disadvantages

To further understand the benefits which ELS, such as ELINOR, can bring to the academic library, ELS must be distinguished from, and compared with, other electronic information retrieval systems. These include OPAC, CD ROM, On-line Databases and the Internet.

#### 2.4.1 OPAC

The OPAC (On-line Public Access Catalogue) provides access to information regarding the variety of information sources held within a library. Although OPAC represents a major progression from the card catalogues and microfiche systems previously employed, its information is limited to bibliographic details (author, title, classmark etc.), and therefore provides insufficient detail to judge a document's relevance. (Relevance refers to the degree to which the document's content relates to the information required). Once a document has been identified users must physically search the shelves for the required item and examine its contents or index in order to judge its relevance. Often, the required item will be on loan to another reader: thus a considerable amount of time may elapse before it can actually be retrieved.

### 2.4.2 CD ROM

The popularity of CD ROM has increased over the last decade due to its ability to store large amounts of information on one disk. There are two types of CD ROM. The first type, usually employed within higher education institutions, comprise large databases of specialised information, for example, LISA (Library and Information Science Abstracts). These databases provide an abstract in addition to bibliographic details, allowing users to judge more effectively an item's relevance without physically locating it. The searching facility of CD ROM is more sophisticated than that of OPAC, using Boolean operators to generate search enquiries. However, this type of CD ROM is still primarily a reference tool. Having located a suitable document from the database, users must again search the library (often using the OPAC) for the relevant item. More often than not, the item will not be stocked by the library and the user must request it via an inter-library loan. The second type of CD ROM offers information in full-text format. However, such CD ROM usually require a new CD to be purchased for each publication. Building a "library" of full-text publications is therefore expensive. Such a collection will also be limited by commercial availability.

### 2.4.3 On-line Databases

On-line Databases provide another source of electronic information retrieval. The information contained within them is stored on magnetic tape or disk which can be accessed by users through a suitable terminal. These databases provide information such as journal contents, abstracts, statistical data, patents, news stories and reports covering a wide variety of fields from science and the arts to media and finance. Although On-line Databases can provide access to massive information repositories there are telecommunications and access costs involved and, as such, downloading or printing documents can be expensive (Mooney, 1995).

### 2.4.4 The Internet

The Internet can be considered as a global network of networks (Mooney, 1995) allowing access to a wide variety of information from all over the world. The nature of its content is constantly changing as each network develops and grows, and complex search tools are employed to deal with requests for information. Although the Internet's potential lies in its ability to enhance global communication, its ever-changing environment makes management of the information in terms of quality, legality and security problematic.

### 2.4.5 Comparison Of Electronic Information Retrieval Systems With ELS

Description of other electronic information retrieval systems has shown that document retrieval can be a lengthy and often expensive process. ELS overcome these problems. ELS such as ELINOR allow representations of ordinary printed documents to be stored on a server, overcoming the problems of physical space and the associated costs of storing printed collections. Institutions with the correct equipment can create and store document images themselves, providing they have access to the original printed versions of the documents. Theoretically, as many publications may be held within the system as desired. However, copyright issues must be agreed with the publisher before documents can be stored on the system (Crawford, 1998; Alrashid et al., 1998). Disk space may also limit storage capacity. Documents produced in-house (such as lecture notes and other course materials) may also be included, meeting the needs of institutions more effectively and providing a more versatile alternative to systems such as the full-text CD ROM. ELS also allow institutions to restrict the availability of documents to certain user groups. This ensures that the copyright agreements gained by individual institutions can be maintained. The necessity to search for documents on the library shelves is eliminated as users may browse the documents without leaving their workstations. Storage of entire documents also means that a closer integration between information retrieval and delivery is possible (Wu et al., 1993). In contrast with the Internet, the electronic library has been developed to solve problems at a local level. However, it must be recognised that the drive for integration of both local and global information sources may change the way ELS are viewed in future. For example, the integration of systems such as ELINOR with the Internet will no longer restrict access to one locality.

The relative merits of each system described in the preceding paragraphs are summarised in Table 2.1.

Table 2.1
The Relative Merits Of Several Electronic Information Retrieval Systems

| | OPAC | CD ROM | Full-Text CD ROM | On-Line Databases | Internet | ELS |
|---|---|---|---|---|---|---|
| Requires no physical storage of printed documents | | | √ | √ | √ | √ |
| Easy to judge document relevance | | | √ | √ | √ | √ |
| No problems of document availability | | | √ | √ | √ | √ |
| Ability to store large amounts of information | √ | √ | √ | √ | √ | √ |
| Inexpensive | √ | √ | | | | |
| Adaptability | √ | | | | √ | √ |
| Manageability | √ | √ | √ | √ | | √ |

### 2.4.6 Further Advantages Of ELS

Additional advantages of ELS are as follows (Ramsden et al., 1994; Wu et al., 1993 and; Collier, 1993).

- The potential exists for the information from an ELS to be shared from multiple access points on the campus. Hence the use of library resources is no longer restricted to the physical locations of libraries. This concept is known as "libraries without walls" (Wu et al., 1993) (Section 2.1). Additional capabilities for widening access lie in integrating ELS with the Internet (Section 2.4.5).

- Time consuming and labour intensive work such as shelving, checking and issuing can be eliminated whilst other on-line services, such as CD ROM, can be integrated.

- ELS may be accessed at any time of the day or night.

ELS have several other advantages with specific reference to higher education (Ramsden et al., 1994; Arnold et al., 1993, 1994; This Quarter: The Business Magazine of De Montfort University, 1994) including the following.

- ELS will improve the quality of, and access to, information services. Problems associated with increasing student numbers, dwindling resources and limited library budgets will thus be eased.

- The trend in higher education is towards student centred learning with emphasis on resource based investigative learning. Given a sufficient material base and functionality, ELS are expected to facilitate the production of higher quality work which is better informed, better researched and more up to date.

- There is also a trend towards distance learning as the traditional profile of students in higher education changes to include a greater proportion of mature, working students or those with domestic commitments who are unable to attend full-time courses. ELS will allow these 'independent learners' and also disabled students access to the full-text of relevant publications at remote locations.

- ELS also provide a storage facility for archived material, enable access to rare and valuable resource material, and provide a way of saving, for posterity, works which are deteriorating rapidly.

### 2.4.7 Barriers To The Introduction Of ELS

There are also several barriers associated with the introduction of ELS. Many publishers are concerned about the effect of ELS on book sales, both to students and higher education institutions (Crawford, 1998). The lack of copyright law for the use of documents stored in electronic form is also a major impediment to the introduction of ELS (Ramsden et al., 1994). Usage must be monitored to provide publishers with information on which to base their initial agreement and continued contractual arrangements regarding inclusion of documents within the ELS.

The cost of setting up an ELS may require a substantial outlay in terms of document purchase and copyright issues. The initial hardware costs involved in setting up an ELS will also be substantial although it may be possible to access the ELS via existing computers through a network. A scanner is also required. However, the initial cost may be saved many times over in the long term as purchase of multiple copies and replacement of documents is unnecessary.

ELS could be seen as yet another example of the increasing prevalence of computers in our society. Collier (1994) explains that:

*"books and libraries as artefacts and constructions are emblematic of our culture, irrespective almost of their contents. A threat against the traditional library is a threat against culture"* (p. 4).

Thus many may oppose the ELS concept. However, the electronic library has been developed to solve problems within an educational context and, as such, the future of the book is not, at present, in question. Books purchased for leisure reading or aesthetic purposes will remain an important part of our present society. Even within the educational environment ELS have the current disadvantage of being less portable and it will take time for people to become accustomed to its use. As Crawford (1998) states:

*"Books matter, and will continue to matter, because people learn from them and enjoy reading them"* (p. 48).

## 2.5 Individual Differences And The Design Of Effective ELS

In order for any computer system to operate effectively it must be capable of creating an environment in which tasks can be carried out with ease, enabling users to concentrate on the task in hand without being encumbered with awkward features of the system's design. In order to achieve system effectiveness designers must therefore obtain a thorough understanding of those who will eventually use the system (Shneiderman, 1987). The diversity which exists between users of computer systems may be very large and include many different characteristics. However, as the user population will be determined largely by the purpose for which the system is designed, it is reasonable to assume that the population may differ in both the nature and extent of its diversity depending on the type of system in question. For example, designers of an expert system for use by researchers working in a highly specialised scientific field may find less diversity in the user population than designers of a system which has many different applications.

The field of Library and Information Science recognises the significance of understanding the behaviour of users of information retrieval systems. The work of Hsieh-Yee (1993) provides an insight into the literature conducted in on-line searching since 1979 and provides both a comprehensive understanding of the developments which have taken place within the area and the current state of research. Two distinct themes are identified by Hsieh-Yee. Firstly, the concern for searcher performance, which has led to search outcome variables such as precision (the probability that a retrieved item is relevant) and recall (the probability that a relevant item in the file is retrieved) becoming standard measures of performance. Secondly, the development of a strong interest in identifying a profile for the effective searcher. In addition to the benefits which this brings in terms of the recruitment, selection and training of searchers, Ford and Ford (1993) explain that a cognitive theory of how people might optimally interrogate databases in order to satisfy particular information needs is required in order to design more effective information retrieval systems. Many characteristics of searchers have been investigated in attempts to find a correlation between individual differences and information retrieval behaviour, for example:

- discipline (Ellis, Cox and Hall, 1993; Borgman, 1989; Balaraman, 1991)
- topic knowledge and search experience (Allen, 1991; Hsieh-Yee, 1993)
- learning style (Logan, 1990; Palmer, 1991; Ford and Ford, 1993; Saracevic et al., 1988)
- technical aptitude (Borgman, 1989; Balaraman, 1991)
- age (Leventhal et al., 1994)

A subset of research which has investigated the relationship between learning style and information retrieval is reviewed in Chapter 4. The majority of research into user characteristics and information retrieval within the library field has taken place with systems such as OPAC, CD ROM, on-line databases or Hypermedia systems. However, the characteristics and preferences of users are also recognised as important to the design and development of the electronic, or digital, library (Spink et al., 1998; Van House et al., 1996; Peterson Bishop, 1995). User-centred methods for evaluating the digital library have also been discussed at conferences such as ELVIRA (Electronic Library and Visual Information Research) (Davies, 1996; Vranch et. al., 1996) and the Allerton Institute (Clement, 1995).

The importance of cognitive and learning processes to the design of computer systems has been recognised by a number of researchers. For example, Shneiderman (1987) suggests that understanding the cognitive and perceptual abilities of users is vital for designers of interactive systems, these characteristics having a profound influence on system design. In research regarding cognitive style and the design of Management Information Systems (MIS), Bariff and Lusk (1977) state that:

> *"The successful development and implementation of an information system should explicitly involve consideration of the psychological disposition of the system's user."* (p.820).

De Diana et al. (1994) emphasise the advantages to be gained from adapting Electronic Study Books to individual learning styles, stating that the opportunity for the learner to control the process of learning may result in a positive influence on the learning outcome. This will arise as learners become more interested, invest more energy in understanding the information, use more self-reflection and become more self-confident. Electronic Study Books may be considered similar to ELS in the fact that they provide computerised representations of documents for the purposes of study. The advantages to be gained from adapting electronic study books to learning styles may also be applicable to ELS. Thus an understanding of individual differences in cognitive processes, including learning style, is essential to the design of effective ELS.

Little research has been found which investigates the relationship between cognitive or learning style and information retrieval within the ELS environment. Research in this area is currently being undertaken by Spink et al. (1998). However, the investigation is not yet complete.

The research described in this thesis will provide an indication of whether learning style requires consideration in the design of ELS and the functionality necessary to facilitate information retrieval by different learning style groups.

**Summary**

This chapter introduced the electronic library concept and described the benefits which it brings to higher education. A detailed description of an example ELS, ELINOR, was provided to illustrate the functionality which such systems may comprise. A growing interest in the electronic library was reported, resulting from several initiatives commissioned to promote the adoption of electronic libraries within higher education. Finally, research into individual differences was identified as having significance to the design of effective information retrieval systems, including ELS. An understanding of differences in learning styles is considered to be of particular benefit. Chapter 3 provides an overview of various learning styles and instruments for their identification.

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# CHAPTER 3

## LEARNING STYLE

Chapter 2 introduced the concept of the electronic library and the benefits it brings to higher education establishments. The need for effective ELS was also recognised, research into individual differences being fundamental to the design of systems which can satisfy the needs and preferences of target users. An understanding of individual differences in learning styles was seen to be of particular importance in the design of effective systems. The present chapter focuses on the concept of learning style. Section 3.1 provides an insight into the variety of ways in which the concept has been defined. Section 3.2 describes a subset of the different approaches which have been taken in identifying and measuring learning styles. Finally, Section 3.3 compares and contrasts the various learning styles identified in Section 3.2.

### 3.1 Defining The Concept Of Learning Style

Learning can be defined as *"A relatively permanent change in knowledge, behaviour or understanding that results from experience."* (A Student's Dictionary of Psychology, 1988, p. 101). However, the concept of learning "style" is not so easy to determine as it has been used in many different contexts. Honey and Mumford (1992) define the term learning style as *"a description of the attitudes and behaviours which determine an individual's preferred way of learning."* (p. 2). A popular term with which learning style has been used in association is cognitive style. The Concise Encyclopedia of Psychology (1987) suggests that *"An individual's cognitive style is determined by the way he or she takes note of the surroundings, seeks meaning, becomes informed."* (p. 209). Shouksmith (1970) extends this idea explaining that cognitive style is an amalgam of the strategies typically adopted by an individual in an attempt to solve the problems with which he/she is faced. Thus cognitive style is primarily concerned with the information processing and problem solving strategies likely to be adopted by an individual in a wide range of situations or activities. Some believe the terms cognitive style and learning style to mean the same and have used the terms interchangeably. Others consider them to be different and attempt to define them as separate concepts (Riding and Cheema, 1991). Palmer (1991) states that learning style is a potentially important aspect of cognitive style related to information seeking behaviour. Thus learning style may also be viewed as an integral component of cognitive style.

The free use of the terms cognitive style and learning style leads to confusion as to the scope of these concepts, and differences between them. Riding and Cheema (1991) suggest that this confusion has arisen from the failure of researchers within the field to distinguish between various tests of cognitive/learning style which may measure similar, or different, aspects of the cognitive or learning process. Entwistle (1996) cites Lewis (1976) stating that *"different groups of researchers seem determined to pursue their own pet distinctions in cheerful disregard of one another ..."* (p. 216). Newble and Hejka (1991) attribute differences in perspectives regarding learning style to differences in the theoretical bases used. For instance, cognitive and psychometric psychologists attribute differences in learning to individual characteristics, whereas educational psychologists view the educational setting as determining the way in which students learn. The focus of cognitive psychologists therefore lies with information-processing strategies and personality traits, whereas educational psychologists focus on the context in which learning takes place. Riding and Cheema (1991) suggest the meaning of the two terms is very much up to the individual, finding over 30 characteristics referred to as cognitive/learning styles. Reynolds (1997) also suggests the meaning of the terms cognitive style and learning style is dependent on individual perspective, but that no matter how it is described or conducted, research into this topic is attempting the same aim: to understand the way in which people learn. Thus cognitive style may also be considered as synonymous with learning style. This is the view adopted for the purposes of this research.

Confusion also exists regarding the concepts of learning style and personality. For example, Borgman (1989) employed the MBTI and LSI in identifying attributes described as personality characteristics. However, the MBTI and LSI are identified as measures of learning style in

Sections 3.2.1 and 3.2.4, respectively. No explanation is provided by Borgman of the context in which the term "personality" is used. Therefore, it is unclear whether Borgman views learning style as synonymous with, or as an element of, personality. Balaraman (1991) also employed the MBTI and LSI in similar research. However, whilst the LSI is described by Balaraman as measuring learning style, the MBTI is described as a test of personality. This suggests that Balaraman views personality and learning style as different concepts. The work of Borgman (1989) and Balaraman (1991) is reviewed in Chapter 4. For the purposes of this research learning style is viewed as one element of an individual's personality.

## 3.2 Approaches To Learning Style

This thesis does not aim to provide a catalogue of learning styles or instruments for their measurement. However, a subset of styles considered key to this research, and instruments for their identification, are briefly described in Sections 3.2.1 to 3.2.6, inclusive. Further information regarding a variety of other learning styles and test instruments, may be found in volumes of the Mental Measurements Yearbook (e.g. Impara and Plake, 1998) and Tests in Print (e.g. Murphy, Impara and Conoley, 1994), both of which are published annually.

### 3.2.1 Jung's Psychological Types

According to Jung all people possess two information intake functions and two information processing functions (McIntyre and Capen, 1993). The information intake functions are described as Sensing, which emphasises the five traditional senses for information intake and; Intuition, which emphasises the generation of information in a creative and often holistic fashion. The information processing functions are described as Thinking, signifying conventional, deductive logic in decision making and; Feeling, signifying values and conflict in decision making. Table 3.1 has been taken from the work of McIntyre and Capen (1993) and provides an illustration of the characteristics associated with each function.

Table 3.1
Characteristics Of The Information Intake And Decision Making Functions
Source: McIntyre and Capen (1993)

| Perceiving (Information Intake) | | Judging (Information Processing) | |
|---|---|---|---|
| Sensing | Intuition | Thinking | Feeling |
| Details | Patterns | Head | Heart |
| Present | Future | Objective | Subjective |
| Practical | Imaginative | Justice | Harmony |
| Facts | Innovations | Cool | Caring |
| Sequential | Random | Impersonal | Personal |
| Directions | Hunches | Criticise | Appreciate |
| Repetition | Variety | Analyse | Empathise |
| Enjoyment | Anticipation | Precise | Persuasive |
| Perspiration | Inspiration | Principles | Values |
| Conserve | Change | | |

A combination of both the preferred mode of information intake and the preferred mode of information processing results in cognitive style. These cognitive styles comprise ST (Sensory-Thinkers), NT (Intuitive-Thinkers), SF (Sensory-Feelers) and NF (Intuitive-Feelers). McIntyre and Capen (1993) explain that although a person's cognitive style is dominated by one information intake function and one information processing function, the remaining functions will also have some influence on a person's behaviour. Figure 3.1 illustrates some salient characteristics of the four cognitive styles.

Figure 3.1
Characteristics Of Cognitive Styles
Source: McIntyre and Capen (1993)

T

**ST (Sensory-Thinker)**

Real-time, operational-technical problem solvers
Concerned with technical detail
Logical analysis of hard data
Orderly, precise
Careful about rules/procedures
Facts oriented with logic
Responsible and dependable
Low tolerance for ambiguity
Concerned with proper roles
The organisation person
**Good at:**
Observing and ordering
Filing and recalling
**Goal:** To do it right

**NT (Intuitive-Thinker)**

Future-time, strategic-technical problem generators
Speculative
Emphasise understanding
Theories are primary
Synthesise and interpret
Ideas oriented with logic
Objective, impersonal, idealistic
Task oriented
Competency important
Ill-defined and abstract situation
**Good at:**
Discovery and inquiry
Problem solving
Comparing and contrasting
**Goal:** To think things through

S — N

**SF (Sensory-Feeler)**

Real-time, operational-people problem solvers
Interpersonal
Subjective
Specific detail
Sympathetic and friendly
Family oriented
Nurturer and supporter
Facts oriented with people
Culture bearer
Open communication
Personal interaction
Respond to people now
**Good at:**
Empathising
Co-operating
Personalising
**Goal:** To be helpful

**NF (Intuitive-Feeler)**

Future-time, strategic-people problem generators
Insightful, mystical
Personal, idealistic
Creator/originator
Life as a seamless whole
Global ideas oriented with people
Subjective
Human potential
Existential concerns
**Good at:**
Imagining
Forming hypotheses
Making new combinations
**Goal:** To make things beautiful

F

The Myers-Briggs Type Indicator (or MBTI) is based on Isabel Myers' interpretation of Jung's theory of psychological types (McHenry, 1994). The MBTI consists of 100 questions which ascertain how individuals perceive and judge. It measures four bipolar dimensions as described by the Concise Encyclopedia of Psychology (1987) as follows.

- *Extraversion versus Introversion*: whether a person's attention is directed towards people and things or towards ideas.
- *Sensing versus Intuition*: whether a person prefers to perceive information by the senses or by intuition.
- *Thinking versus Feeling*: whether an individual prefers to use logic and analytic thinking or feelings in making judgements.
- *Judgement versus Perception*: whether an individual uses judgement or perception as a way of life. That is, does the individual evaluate events in terms of a set of standards or simply experience them?

Thus the test labels people as Extraverted or Introverted (E or I); Sensing or Intuitive (S or N); Thinking or Feeling (T or F) and; Perceiving or Judging (P or J). The categories are then combined into 16 types labelled, for example, INTJ, ESTJ or ENTP. Examples of these types have been taken from Robbins (1991).

- INTJ's are visionaries. They usually have original minds and great drive for their own ideas and purposes. They are characterised as sceptical, critical, independent, determined and often stubborn.
- ESTJ's are organisers. They are practical, realistic, matter of fact, with a natural head for business or mechanics. They like to organise and run activities.
- The ENTP-type is a conceptualiser. He or she is quick, ingenious, and good at many things. This person tends to be resourceful in solving challenging problems, but may neglect routine assignments.

### 3.2.2 Witkin's Field Dependence And Field Independence

Witkin identifies two distinct learning styles, described as Field-Dependence and Field-Independence (Shouksmith, 1970). Citing Witkin, Moore, Goodenough and Cox (1977), Liu and Reed (1994) state that the two styles refer to:

> *"the extent to which a person perceives part of the field as discrete from the surrounding field as a whole, rather than embedded in the field; or (...) the extent to which the person perceives analytically"* (p. 420).

The "field" may refer to a set of thoughts, ideas or feelings. Field-Independent people are characterised by the ability to impose a structure where there is none and an inclination to analyse situations from a detached perspective (Concise Encyclopedia of Psychology, 1987). Field-Independent people are more active in perceptual tasks, and when solving conceptual problems are more able to structure and restructure data (Terelak, 1990). Field-Dependent people are characterised by the tendency to take a more "global" approach to situations being dominated by context when making judgements (A Student's Dictionary Of Psychology, 1988). They seek social feedback but are rather poor in restructuring data (Terelak, 1990). Liu and Reed (1994) indicate that the term "Field-Mixed" is sometimes used to describe people who do not have a clear orientation towards either Field-Dependency or Field-Independency. The Group Embedded Figures Test (GEFT) may be used to identify Field-Dependence and Field-Independence (Liu and Reed, 1994). The GEFT is a timed pencil and paper test designed to measure the ability or skill required in finding simple figures "hidden" in a complex field (Howe and Doody, 1989). The higher the score, the greater the Field-Independence of the respondent; the lower the score, the greater the Field-Dependence of the respondent (Murphy, 1993).

### 3.2.3 Adaption-Innovation Theory

Kirton (1976) explains that everyone can be located on a continuum ranging from an ability to "do things better" to an ability to "do things differently", and the ends of this continuum are labelled adaptive and innovative respectively. A description of the behaviour associated with both Adaptors and Innovators is provided in Table 3.2.

Table 3.2
Descriptions Of The Behaviour Associated With Adaptors And Innovators
Source: Kirton (1976)

| Adaptors | Innovators |
|---|---|
| Characterised by precision, reliability, efficiency, methodicalness, prudence, discipline, conformity. | Seen as undisciplined, thinking tangentially, approaching tasks from unsuspected angle. |
| Concerned with resolving problems rather than finding them. | Could be said to discover problems and discover avenues of solution. |
| Seek solutions to problems in tried and understood ways. | Queries assumptions; manipulates problems. |
| Reduces problems by improvement and greater efficiency, with maximum continuity and stability. | Is catalyst to settled groups, irreverent of their consensual views; seen as abrasive, creating dissonance. |
| Seen as sound, conforming, safe, dependable. | Seen as unsound, impractical; often shocks his or her opposite. |
| Liable to make goals of means. | In pursuit of goals treats accepted means with little regard. |
| Seems impervious to boredom, seems able to maintain high accuracy in long spells of detailed work. | Capable of detailed routine work for only short bursts. Quick to delegate routine tasks. |
| Is an authority within given structures. | Tends to take control in unstructured situations. |
| Challenges rules rarely, cautiously, when assured of strong support. | Often challenges rules, has little respect for past custom. |
| Tends to high self-doubt. Reacts to criticism by closer outward conformity. Vulnerable to social pressure and authority; compliant. | Appears to have low self-doubt when generating ideas, not needing consensus to maintain certitude in face of opposition. |
| Is essential to the functioning of the institution all the time, but occasionally needs to be 'dug out' of his (or her) systems. | In the institution is ideal in unscheduled crises, or better still to help to avoid them, if he or she can be controlled. |

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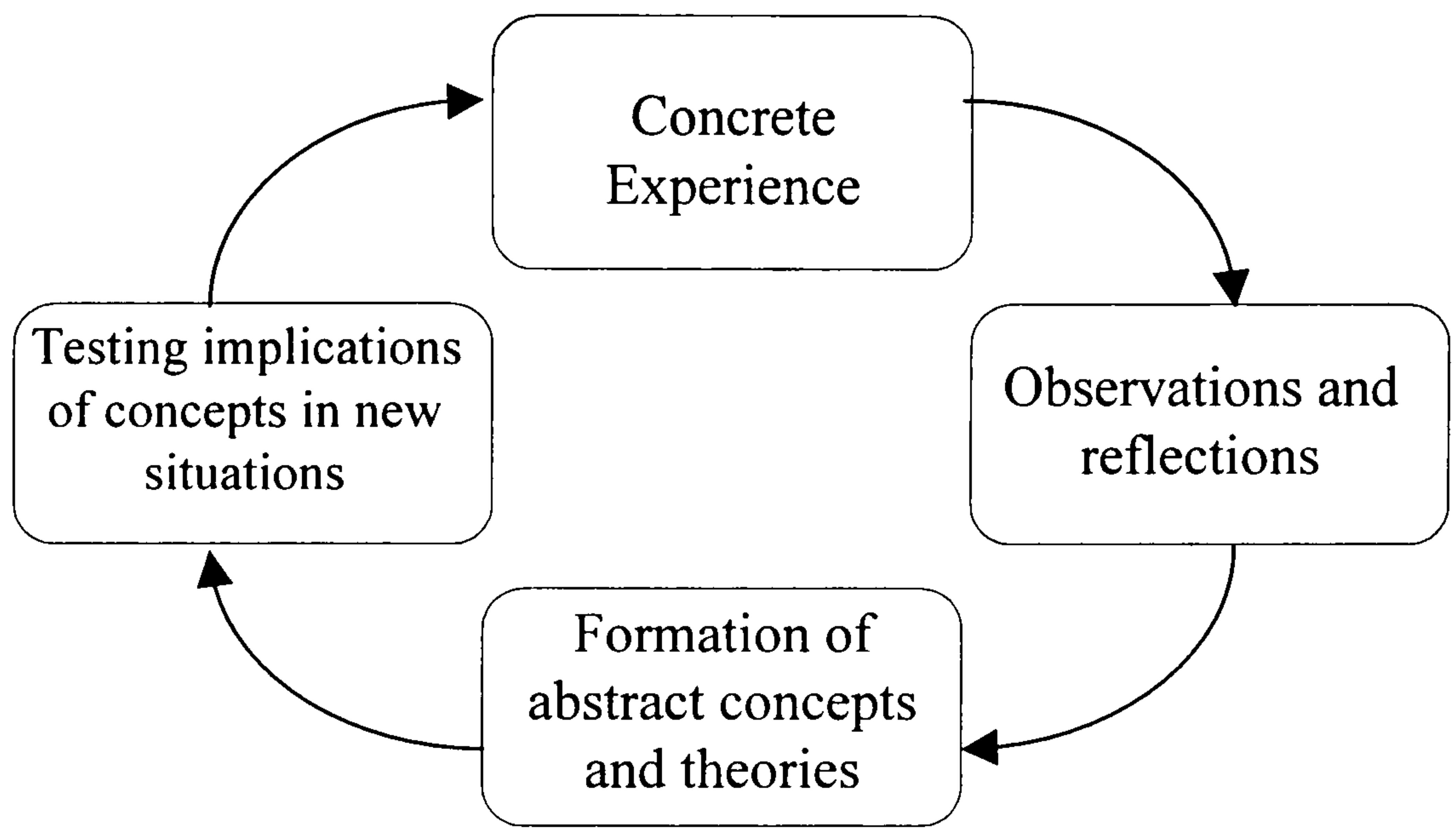
The Kirton Adaption-Innovation Inventory (KAI) provides a measure of the degree to which people are "adaptive" or "innovative" in their cognitive style with regard to creativity, decision-making and problem-solving. It is a self-report inventory consisting of statements describing attributes such as problem attack, disposition toward team work, consistency and thoroughness. Respondents are required to rate the difficulty of sustaining, for long periods, behaviour consistent with these statements. Difficulty can be rated by categories such as Very Hard, Hard, Easy and Very Easy. An unlabelled middle option is also provided for those unable to distinguish between Hard and Easy. The KAI is untimed but is estimated to take between five and ten minutes to complete. Kirton (1976) explains that the cognitive styles of Adaption and Innovation are common to everyone and are manifest in any situation where creativity, problem solving and decision-making are applicable.

### 3.2.4 Experiential Learning Theory

Experiential learning theory, developed by Kolb, provides a simple model of the learning process described as stages in a cycle. These stages, and their relationship with one another, are depicted in Figure 3.2 which has been taken from the work of Talbot (1985). White (1992) explains that the model offers an understanding of patterns of problem solving, looking at one's ability to recognise, define and solve problems. Strengths or weaknesses in risk taking, imaginative abilities, planning and theory building can be brought to light, and strategies can be created to improve these areas.

Figure 3.2
Kolb's Model Of The Learning Process
Source: Talbot (1985)




In order for learning to be effective, the learner should possess certain abilities. A learner should be able to:

> *"involve himself fully in new experiences, then from various perspectives reflectively create concepts that integrate his observations into theories which can then be used to make decisions and solve problems"* (Talbot, 1985, p. 19).

These abilities relate to Kolb's four learning modes: concrete experience, reflective observation, abstract conceptualisation and active experimentation. The learning modes are described as follows.

1. Concrete Experience (CE)

   This mode focuses on direct involvement with immediate human situations, emphasising feeling rather than thinking, and using an intuitive approach rather than a systematic, scientific approach to problems.

2. Reflective Observation (RO)

This mode focuses on the meaning of ideas and situations through observation and understanding rather than practical application, being concerned with what is true rather than what will work, and emphasising reflection rather than action.

3. Abstract Conceptualisation (AC)

This mode focuses on logic, ideas and concepts, emphasising thinking as opposed to feeling, being concerned with theory building rather than intuitive understanding. It is a scientific rather than artistic approach to problems.

4. Active Experimentation (AE)

This mode emphasises influencing people and change through practical applications rather than reflective understanding. It focuses on pragmatic concern with what works rather than absolute truth: doing rather than observing.

White (1992) explains that concrete experience and abstract conceptualisation are two poles of the dimension of grasping experience, information or ideas. Reflective observation and active experimentation are two poles of the dimension of transforming or processing the stimuli. According to Kolb learning styles comprise a preference for either one or a combination of these dimensions, highlighting the strengths and weaknesses in an individual's approach to learning, development and problem solving. These learning styles are described as follows.

1. Accomodators

Accomodators prefer the learning modes of concrete experience and active experimentation. Their greatest strengths lie in doing things, carrying out plans, and involving themselves in new experiences. Accomodators tend to do well in situations where they must adapt to immediate circumstances. People with this learning style are action-oriented and like to solve problems in an intuitive, trial-and-error manner. They like to execute solutions and initiate problem solving based on some goal or model about how things should be.

2. Divergers

Divergers prefer the learning modes of concrete experience and reflective observation, with strengths in imagination and the ability to see situations from multiple perspectives. Divergers do well in identifying the multitude of possible problems and opportunities that exist in reality, generating ideas and brainstorming.

3. Convergers

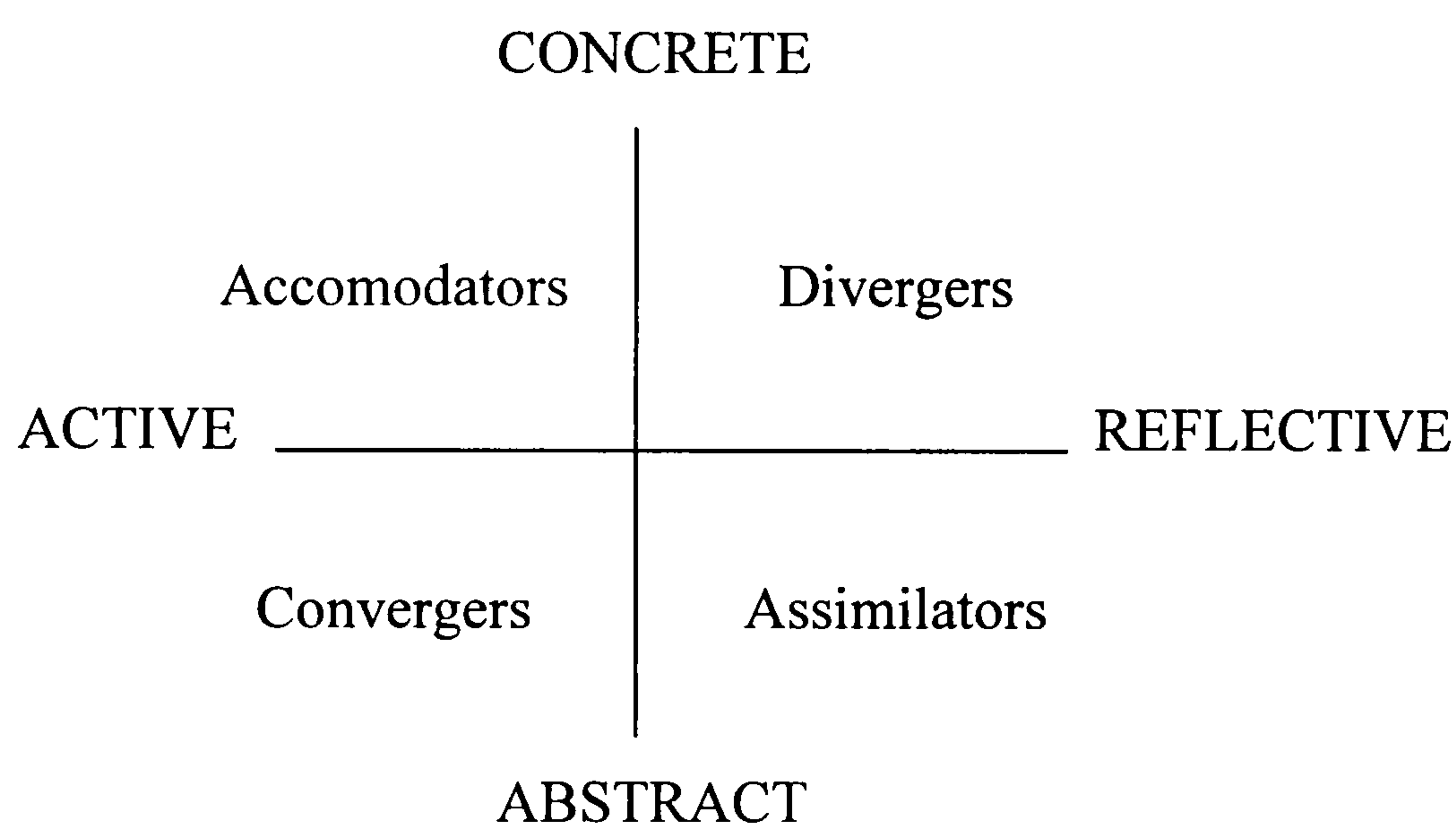
Convergers have the opposite learning strengths of Divergers. They are best at abstract conceptualisation and active experimentation, with strengths in the practical application of ideas. Persons with this dominant learning style tend to excel in the evaluation of solution consequences and solution selection. They use hypothetical-deductive reasoning to focus on specific problems, and prefer to work with things rather than people.

4. Assimilators

Assimilators' dominant learning abilities are abstract conceptualisation and reflective observation. They excel in the ability to create theoretical models and reason inductively in order to choose a high-priority problem and alternative solutions. Assimilators tend to be more concerned with abstract concepts than people or the practical application of theories.

Preferences for the four learning styles described above can be identified using Kolb's Learning Styles Inventory or LSI (sometimes referred to as KLSI). The LSI can increase an individual's awareness of his or her own and others' preferred learning and communication styles (White, 1992). In reviewing Kolb's LSI, Newstead (1992) provides a diagrammatic summary of the relationship between the learning modes and learning styles proposed by Kolb. This is shown in Figure 3.3.

Figure 3.3
Kolb's Learning Styles
Source: Newstead (1992)




Newstead also gives a brief description of the LSI. He explains that the test comprises nine sets of four adjectives as illustrated in Table 3.3.

Table 3.3
The Learning Styles Inventory
Source: Newstead (1992)

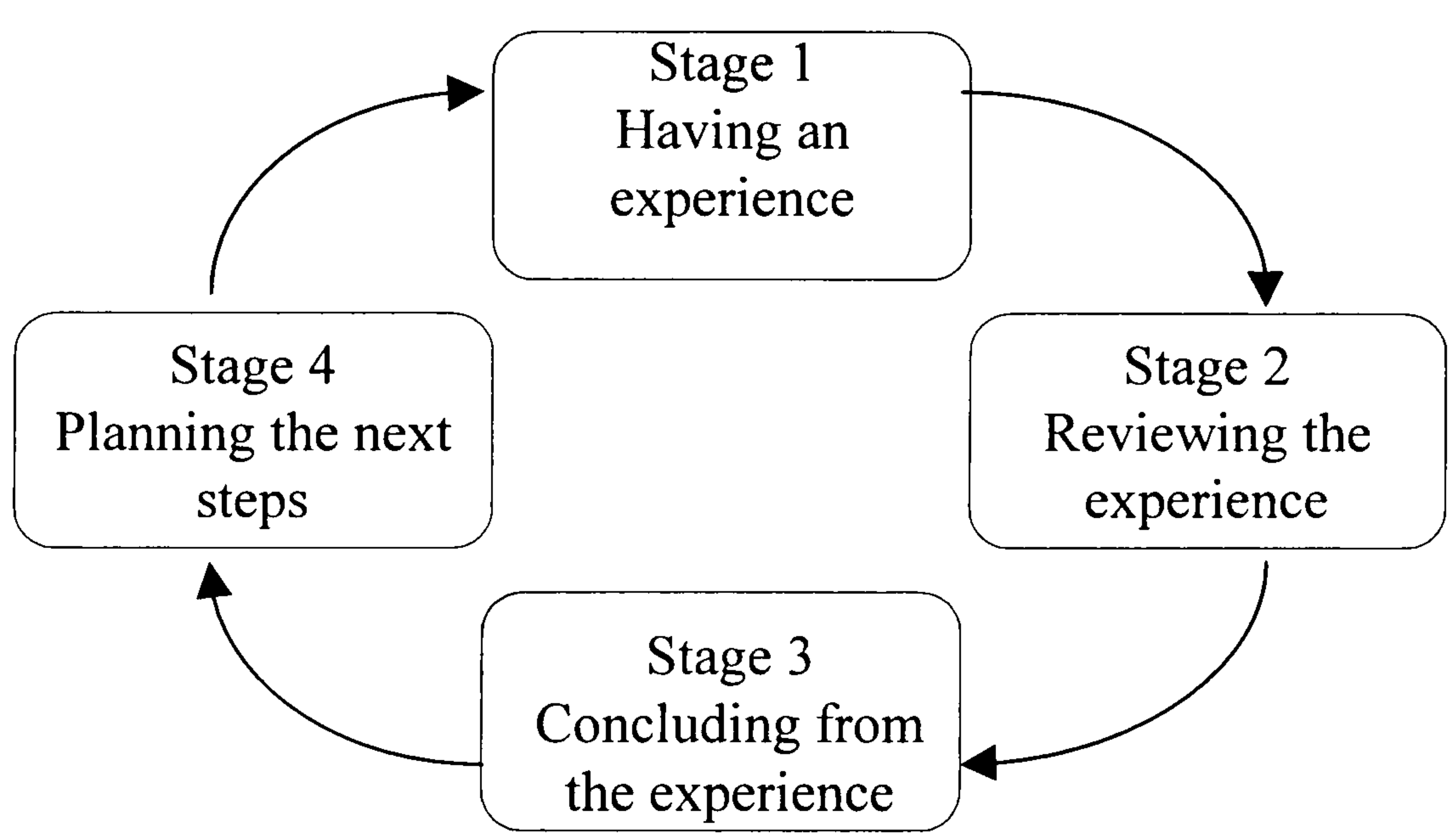
| | | | |
|---|---|---|---|
| discriminating | tentative | involved | practical |
| receptive | relevant | analytical | impartial |
| feeling | watching | thinking | doing |
| accepting | risk-taking | evaluative | aware |
| intuitive | productive | logical | questioning |
| abstract | observing | concrete | active |
| present-orientated | reflecting | future-orientated | pragmatic |
| experience | observation | conceptualisation | experimentation |
| intense | reserved | rational | responsible |

The respondent must rank each adjective according to its accuracy in describing their approach to learning. Scores for the four learning modes (CE, RO, AC, and AE) are obtained by pooling the ranks given to the adjectives. The scores obtained for all four learning modes derives the respondent's position on the two axes in Figure 3.3.

### 3.2.5 Honey And Mumford's Learning Styles

The model of the learning cycle developed by Honey and Mumford (1992) is based on the work of Kolb (Section 3.2.4). The model comprises four stages as depicted in Figure 3.4.

Figure 3.4
Honey And Mumford's Learning Cycle
Source: Honey and Mumford (1992)




The learning cycle represents a continuous, iterative process. The position which a learner occupies at the start of the learning process may depend on the activity being undertaken. Therefore, a learner may not necessarily begin the learning process at stage 1. For example, a learner may begin at stage 4 by developing a technique for undertaking a task. Using this technique would then be concurrent with stage 1. The technique may be reviewed (stage 2) and conclusions drawn regarding its suitability for the task (stage 3). Finally, the technique may be modified in accordance with these conclusions (stage 4). The four stages are mutually supportive, each playing an important part in the total learning process. No individual stage is fully effective as a learning procedure on its own.

Honey and Mumford (1992) explain that the learning process may be distorted as people develop preferences, placing a greater emphasis on certain stages to the detriment of others. Honey and Mumford (1992) provide the following examples of how this may happen.

<u>Example 1</u>

Preferences for experiencing such that people develop an addiction for activities to the extent that they cannot sit still but have to be rushing around constantly on the go. This results in plenty of experiences and the assumption that having experiences is synonymous with learning from them.

<u>Example 2</u>

Preferences for reviewing such that people shy away from first hand experiences and postpone reaching conclusions for as long as possible whilst more data is gathered. This results in an 'analysis to paralysis' tendency with plenty of pondering but little action.

<u>Example 3</u>

Preferences for concluding such that people have a compulsion to reach an answer quickly. This results in a tendency to jump to conclusions by circumventing the review stage, where uncertainty and ambiguity are higher. Conclusions, even if they are wrong ones, are comforting things to have.

Example 4

Preferences for seizing on an expedient course of action and implementing it with inadequate analysis. This results in a tendency to go for 'quick fixes' by over-emphasising the planning and experiencing stages to the detriment of reviewing and concluding.

According to Honey and Mumford (1992), learning styles are the key to understanding these different preferences. Learning styles are, in themselves, learned as successful learning strategies are repeated and unsuccessful strategies discontinued. Honey and Mumford identify four learning styles: Activist, Reflector, Theorist and Pragmatist. The principal characteristics of each style are summarised in Table 3.4. Full descriptions are contained in Appendix B.

Table 3.4
A Description Of Honey And Mumford's Four Learning Styles

| ACTIVISTS | REFLECTORS |
|---|---|
| • Involve themselves fully in new experiences but become bored with longer term implementation issues.<br>• Are open-minded, not sceptical.<br>• Enthusiastic about anything new.<br>• "I'll try anything once".<br>• Tend to act first and consider the consequences afterwards.<br>• Tackle problems by brainstorming. | • Like to stand back and ponder experiences, observing them from many different angles.<br>• Tend to postpone reaching definitive conclusions for as long as possible.<br>• Engage in the thorough collection and analysis of data.<br>• Tend to adopt a low profile and enjoy observing others in action.<br>• Listen to others discussion before making their own points. |
| THEORISTS | PRAGMATISTS |
| • Think problems through in a logical, step-by-step way.<br>• Perfectionists.<br>• Like to analyse and synthesise.<br>• Keen on theories and models, rationality and logic.<br>• Uncomfortable with subjective judgements and ambiguity. | • Keen on trying out ideas, theories and techniques to see if they work in practice.<br>• Act quickly and confidently on ideas that attract them.<br>• Impatient with open-ended discussions.<br>• Practical and down to earth.<br>• Respond to problems as a challenge. |

Honey and Mumford developed the Learning Styles Questionnaire (LSQ) as a measure for identifying preferences for each of the four learning styles. A copy of the LSQ and a description of the method for its scoring and interpretation are included in Appendix B. The LSQ consists of eighty short, numbered statements with which the respondent must indicate if he or she agrees by placing a tick or a cross in the appropriate box. These statements relate to characteristics associated with each of the four learning styles summarised in Table 3.4. The LSQ also identifies the strength of the preference. This is categorised as being either very strong, strong, moderate, low or very low. Respondents may have an equal preference for more than one learning style. The most common combinations are:

Reflector/Theorist
Theorist/Pragmatist
Reflector/Pragmatist
Activist/Pragmatist

The other two combinations (Activist/Reflector and Activist/Theorist) are less likely to occur, there being very little correlation between them.

The LSQ has been adopted for identifying the learning styles of the target population within the research described in this thesis. Its characteristics match the research requirements which include reliability, validity and ease of administration. The instructions for using and interpreting the LSQ are well documented and a clear description of the characteristics associated with each of the four learning styles is also provided. The LSQ is a self-report inventory, can be copied freely and was immediately available to the author. These aspects are discussed in Chapter 5.

### 3.2.6 Holism And Serialism, And Comprehension Learners And Operation Learners

Pask (1976) describes different approaches to learning in terms of 'holism' and 'serialism'. Holism refers to a 'description building' approach to learning, whereby broad descriptions of a subject are built into which details may then be fitted. Serialism refers to a 'procedure building' approach, whereby small units of information are identified, sequentially organised and linked together until an overall picture emerges (Ford, 1985). Pask (1976) explains that holism and serialism are extreme manifestations of learning processes suggesting that in most learning situations students are either disposed to act 'like holists' or 'like serialists'. Pask classifies these individuals as 'comprehension learners' and 'operation learners' respectively, explaining that it is more appropriate to view learning styles in terms of the distinctions between comprehension and operation learners rather than in terms of holism or serialism. The characteristics of both comprehension and operation learners are necessary for understanding any topic and thus the distinction between them is a matter of degree. Students able to act in either way are referred to as 'versatile'. The characteristics associated with comprehension and operation learners are described as follows.

Comprehension learners

Comprehension learners readily pick up an overall picture of the subject matter and recognise clearly where information can be obtained. They are able to build descriptions of topics and to describe the relationship between topics. Pask (1976) explains that the cognitive repertoire of comprehension learners includes effective, though individually distinctive, description building operations, although such learners may not be able to apply these operations to specific subject information (for example, to classify specimens) until the procedures underlying the concepts in question are specifically taught.

Operation learners

Left to their own devices, operation learners pick up rules, methods and details, but are often unaware of how or why they fit together. They have a sparse mental picture of the material and their recall of the way they originally learned is guided by arbitrary number schemes or accidental features of the presentation. However, Pask (1976) explains that if an operation learner is provided with a specific description, he or she assimilates procedures and builds concepts for isolated topics.

The Short Inventory of Approaches to Studying, developed by Entwistle, identifies a number of factors relating to learning style including comprehension, operation and versatile learning styles (Ford, 1985). The test is a self-completion inventory and provides information primarily on the presence of description-building and procedure-building abilities. However, it does not assess the extent to which one or other component of learning is used first or predominantly in the learning process. In contrast, the Study Preference Questionnaire is concerned with the sequence in which the components of learning are used. The Study Preference Questionnaire was developed for use in a study which *"sought to explore the extent to which a group of experienced and successful learners (...) might be expected to be versatile learners ..."* (Ford, 1985, p. 65). It is therefore designed to assess preferences for description-building before procedure-building or vice versa amongst comprehension, operation and versatile learners, thus giving information which Entwistle's inventory does not provide. The Study Preference Questionnaire also includes items relating to reading and information seeking activities which might also be related to description-building or procedure-building preferences.

The Study Preference Questionnaire comprises 18 pairs of statements as illustrated in the example below taken from Ford (1985):

| | | | | | | |
|---|---|---|---|---|---|---|
| When reading a book (or other information source) for my studies, I generally tend to concentrate on certain parts, and skip over others quite markedly, going back later if necessary to fill in any 'gaps' or 'missing links'. | 1 | 2 | 3 | 4 | 5 | I tend to follow the author's presentation reasonably closely, rather than skipping about a lot. |

Respondents are required to select a number on the scale of one to five depending on the extent to which they agree with each statement. The following rules must be observed in responding.

1 = I agree with the statement on the *left.*

2 = I agree (with reservations) with the statement on the *left.*

3 = No preferences for either statement.

4 = I agree (with reservations) with the statement on the *right.*

5 = I agree with the statement on the *right.*

## 3.3 A Comparison Of Learning Styles

Despite the different approaches to learning style described in Sections 3.2.1 to 3.2.6, a number of styles bear similarity with one another. These styles may be separated into two broad categories: those which emphasise a propensity for method, precision, problem solving and a liking for practicality, details, sequence and direction and; those which emphasise a propensity for subjectivity and intuition, being action-oriented and lacking detail, structure or direction in thought. To avoid repetition of the classification given to the learning styles reviewed in this chapter, and any which may exist elsewhere, these categories have been labelled "category one" and "category two" respectively. Table 3.5 gives the styles relating to each of these categories.

Table 3.5
A Two Category Classification Of The Learning Styles Reviewed In Sections 3.2.1 To 3.2.6.

| Category One | Category Two |
|---|---|
| Sensory-Thinkers (Jung) | Intuitive-Feelers (Jung) |
| Adaptors (Kirton) | Innovators (Kirton) |
| Assimilators (Kolb) | Accomodators (Kolb) |
| Theorists (Honey and Mumford) | Activists (Honey and Mumford) |
| Operation Learners (Pask) | Comprehension Learners (Pask) |
| Field-Independence (Witkin) | Field-Dependence (Witkin) |

Several of the approaches to learning described in this chapter identify four rather than two styles. Whilst two out of the four styles may be placed within the classification presented in Table 3.5, the other two do not fit into it easily. Styles which are difficult to classify are Kolb's Convergers and Divergers; Jung's Intuitive-Thinkers and Sensory-Feelers and; Honey and Mumford's Reflectors and Pragmatists. Convergers, Divergers, Intuitive-Thinkers and Sensory-Feelers occupy a midpoint between categories one and two, bearing characteristics congruent with both. Some of the characteristics associated with Reflectors and Pragmatists are similar to those of the Activist and Theorist learning styles within categories one and two. Other characteristics of Pragmatists and Reflectors are not typical of either style. For example, Pragmatists have the tendency to act quickly on attractive ideas. However, their primary objective is to complete the task in hand, in whichever way is most practical. Neither Activists nor Theorists emphasise this characteristic. Reflectors, like Theorists, also engage in the thorough collection and analysis of data. However, their tendency to consider data and experiences from many angles differentiates them from Theorists and Activists. The 16 psychological types identified by the MBTI are also difficult to classify. Each type reflects different combinations of characteristics derived from the four cognitive styles identified by Jung.

Comparing the characteristics of learning styles identified by different instruments illustrates little difference in the nature of what is being measured. A number of the styles identified by different approaches bear similar characteristics, even though they are described by different names. The LSQ has been employed within this research (Section 3.2.5). The similarity between the characteristics identified by both the LSQ and alternative instruments suggests that similar research outcomes may be observed from the employment of other instruments. However, this cannot be assumed. It is outside the scope of this research to investigate this issue. It has therefore been identified as an opportunity for further research in Section 9.6.

**Summary**

Chapter 2 explained that an understanding of individual differences in learning style is considered to be of particular benefit to the design of effective information retrieval systems, including ELS. The present chapter illustrates that the concept of learning style has been perceived, and defined, in a number of different ways by researchers in the field. This has led to indeterminacy in its nature. Sections 3.2.1 to 3.2.6 illustrate the variety of approaches which have been taken in the identification and measurement of learning style. However, when compared with one another, the learning styles reviewed bear a certain degree of similarity with one another. This suggests that various methods employed in measuring learning style identify very similar characteristics.

Chapter 4 reviews research which explores the relationship between learning style and information retrieval from a variety of systems. The extent to which this research is of use in providing a basis for researching the relationship between learning style and information retrieval from ELS is also examined.

# CHAPTER 4

## A REVIEW AND ANALYSIS OF PREVIOUS RESEARCH INTO THE RELATIONSHIP BETWEEN LEARNING STYLE AND INFORMATION RETRIEVAL

Chapter 2 emphasised that an understanding of the relationship between learning style and information retrieval is of significance to the development of effective information systems, including ELS. Chapter 3 explained that learning style has been defined in a variety of ways and that different approaches have been taken in its identification and measurement. Previous research regarding learning style and information retrieval has not focused specifically on ELS. Within the present chapter, Section 4.1 reviews research which has investigated the relationship between learning style and information retrieval from a variety of systems. Section 4.2 evaluates the research in terms of its use in providing a basis for studying the relationship between learning style and information retrieval from ELS.

### 4.1 The Relationship Between Learning Style And Information Retrieval: A Literature Review

Several researchers have explored the relationship between learning style and information retrieval. For instance, Palmer (1991) investigated the influence of learning style, discipline and organisational structure on the information behaviour of 67 biochemists, entomologists and statisticians working at an agricultural research station. A cluster analysis was used to group the subjects as to their information seeking behaviour and attitudes. The cluster analysis revealed five groupings, the characteristics of which are summarised as follows.

Non-seekers

- Heavy use of electronic mail.
- Computers viewed as essential to work but not important for information gathering.
- Journals and conferences of less importance than for other groups.
- Abstracts and indexes never used.
- Information gathering activities viewed either as problematic or disregarded since information is rarely sought for problem-solving.

- Contacts outside the departments rare.
- Few have any ongoing information-gathering routines.

Lone, wide rangers

- Preference for working alone.
- Uses serendipity in solving problems.
- Wide information gathering habits.
- Heavy reliance on own knowledge and experience.
- Personal contacts considered important.
- Projects not planned in detail.
- Random information gathering habits.
- Actively seeks a constant stream of useful and relevant information from colleagues and contacts outside the organisation.

Unsettled, self-conscious seekers

- Conscientious information seekers, using the library more heavily for routine information gathering than any other group.
- Colleagues contacted first in preference over other ways of finding information.
- Few frequent contacts outside institute.
- Use of card indexes for references and offprint collections.

Confident collectors

- Regular information-gathering routines abandoned by many.
- Belief that access to all the necessary and important information is afforded through a variety of activities.
- On-line service used regularly.
- Theses important source of information.
- Complex methods of organising information.
- Card indexes viewed as of little use and abandoned in many cases.
- Clear boundaries to research interests.
- Not dependent on others for information.

Hunters

- Driven by the information demands of their subject area, which is fast-moving.
- Devise strategies to ensure important information is not missed.
- Maintain regular information-gathering routines, sometimes visiting the library on a daily basis.
- Maintain frequent contacts outside the organisation both nationally and internationally.
- Heavy use of on-line searching.

The KAI and the LSQ were employed to ascertain whether learning style characteristics might correlate with the groups identified. Regarding the KAI (described in Section 3.2.3), it was found that Non-seekers and Unsettled, self-conscious seekers had a mild preference for the

Adaptor style, whilst Lone, wide rangers and Hunters were Innovators. Confident collectors did not show a strong preference for either the Innovator or Adaptor style. Regarding the LSQ (described in Section 3.2.5), Non-seekers were found to have a marked preference for the Reflector style, a moderate preference for the Theorist and Pragmatist styles and low preference for the Activist style. Lone, wide rangers and Hunters were clearly Activists. Unsettled, self-conscious seekers had low scores for the Activist style, but scored high regarding the Reflector, Theorist and Pragmatist styles. Confident collectors showed a marked preference for the Activist style but also scored high for the Theorist style. Palmer (1991) claims that the KAI and LSQ provide a link between learning style and types of information behaviour, as identified by the cluster analysis. However, Palmer also found that the information behaviour of individuals is influenced by factors such as discipline and subject area. For example, high scoring Innovators might prefer a diverse and wide ranging method of information seeking, but if they are working in a discipline which is "fast moving" and in which new information is constantly being generated, they may adapt their information behaviour in order to keep abreast of new developments within the field. However, the less flexible Adaptors might show similar patterns of information behaviour no matter what the discipline requires.

Saracevic et al. (1988) studied the effect on search performance of a wide variety of factors relating to five broad categories of information seeking and retrieving. These categories were: users, questions, searchers, searches and items retrieved. A comprehensive description of all the factors studied would be too extensive to report here. Furthermore, this chapter is concerned with research regarding cognitive/learning style and information retrieval. As many of the factors studied by Saracevic et al. do not relate to cognitive/learning style, their description within this thesis is inappropriate. A full account may be found in Saracevic et al. (1988), parts I, II and III.

Saracevic et al. (1988) examined the relationship between learning style and information retrieval from the DIALOG system. Searchers performed searches relating to research questions provided by a number of users. In this instance "users" were referred to as those requiring information about a given topic. "Searchers" were referred to as the information intermediaries with the necessary knowledge and skills to retrieve the required information from the DIALOG system.

The study examined the probability that items retrieved in association with a given characteristic (in this case the learning styles of searchers) would be relevant or partially relevant as opposed to not relevant. The degree of relevance within the items retrieved was judged by the users that had originally submitted the questions using the following guidelines: relevant items were described as documents considered to be related to the question even if the information was outdated or already familiar to the end user; partially relevant documents were described as documents considered to be only somewhat or in some part related to the whole, or any part of, the question; non relevant documents were described as documents which were not at all related to the question. The probability that searches associated with a given characteristic would be of high precision or recall was also examined. Precision was defined as the probability that a retrieved item is relevant; recall was defined as the probability that a relevant item in the file is retrieved. "High" levels of precision and recall were defined as being above the average level established for the study.

The preferred learning styles of 39 professional information searchers were identified using Kolb's Learning Styles Inventory (LSI), described in Section 3.2.4. Section 3.2.4 indicated the existence of four modes of learning within Kolb's model. These were described as concrete experience, reflective observation, abstract conceptualisation and active experimentation. Saracevic et al. (1988) report that levels of relevance, precision and recall were lower in the items retrieved by searchers who preferred a concrete experience mode of learning. Those who showed a preference for an abstract conceptualisation learning mode achieved higher levels of relevance and recall. No significant effect was found regarding the influence of an abstract conceptualisation learning mode on the level of precision. Neither was a significant effect found regarding the influence of active experimentation or reflective observation learning modes on relevance, precision or recall. Saracevic et al. (1988) also report that searchers with a preference for abstractness over concreteness were more likely to retrieve items which were relevant or partially relevant and achieved higher levels of recall. In describing the preferences of these searchers it is assumed that Saracevic et al. are referring to the learning styles suggested by Kolb. A learning style comprises a preference for either one or a combination of Kolb's four modes of learning. Two of these styles indicate preferences for abstractness rather than concreteness. These styles may be identified as Convergers and Assimilators. No significant influence of a preference for abstractness over concreteness was found on levels of precision. The findings from Saracevic et al.'s research indicate that those searchers who possess an analytical, scientific learning style appear to be the most successful in retrieving items of above average levels of relevance and recall. Searchers with more intuitive learning styles are least successful in retrieving such items.

Woelfl (1984) also employed the LSI in research which sought to find whether cognitive characteristics, including learning style, contribute to differences in search behaviour. 44 subjects performed searches on the MEDLINE system: a bibliographic database covering biological and medical journals. Each subject was required to answer four questions using MEDLINE. The results of each search were assessed in terms of precision and recall. Five measures of search related effort were also used. These were:

- Commands: the number of commands issued to the system.
- Descriptors: the number of actual terms for which the system is asked to search.
- Cycles: the number of iterations during a search. A cycle involves three stages: entering the search term, or descriptor; combining descriptors to narrow the search and; printing references.
- Connect time: the total amount of time spent on-line during a search.
- References: the number of records typed or printed out during a search.

Findings were primarily separated into two: the behaviour associated with concrete experience compared with that of abstract conceptualisation and; the behaviour associated with reflective observation compared with that of active experimentation.

Woelfl (1984) found little to indicate that subjects who emphasised concrete experience used more connect time or more commands than those who were highly abstract. Correlations between the number of cycles completed and the two learning modes suggested that concrete subjects invested more effort in searching, there being a positive correlation with concrete experience and a negative correlation with abstract conceptualisation. However, further examination of the search behaviour employed by selected individuals revealed that these differences were as much qualitative as quantitative. Whilst abstract subjects tended to complete their search in one cycle, concrete subjects broke the search down into a number of smaller searches and, hence, used more cycles. Breaking the search down into parts reduces the number of concepts a subject must deal with simultaneously. This appeared to help concrete subjects cope better with the cognitive demands of the on-line search process. Thus Woelfl explains that the number of cycles completed may reflect differences in search organisation and implementation more than differences in search effort. In contrast with the findings of Saracevic et al. (1988), differences between the two learning modes appeared to have no influence on the ability to retrieve relevant references. The different methods employed by abstract and concrete subjects proved equally effective in searching for information.

The differences in search behaviour of subjects situated along the active/reflective dimension of the learning process were more pronounced than between concrete and abstract subjects. It was found that subjects who were highly active used less connect time than those who were highly reflective. Correlations were also found between the two learning modes and each of three measures: the number of commands used, descriptors, and cycles completed. This correlation was positive for those emphasising reflective observation and negative for those emphasising active experimentation. Thus, active and reflective learning modes seem to have more effect on search behaviour than those emphasising abstract conceptualisation or concrete experience. In accordance with the findings of Saracevic et al. (1988), there is little to indicate that either reflective observation or active experimentation have any effect on the ability to retrieve relevant references. However, Woelfl (1984) explains that active subjects are more likely to conduct abbreviated searches and will therefore have less chance of retrieving relevant items. An example of an abbreviated search is given as one in which three half minutes of connect time, a single cycle and only six commands were used. Because of the indirect relationship between search effort and outcome, it may be said that there are differences in the number of relevant items retrieved by reflective and active subjects. The overall findings from Woelfl's study indicate that differences in learning modes have little effect on the outcome of a search in terms of the number of relevant references produced, but may influence search behaviour in terms of the effort employed in searching.

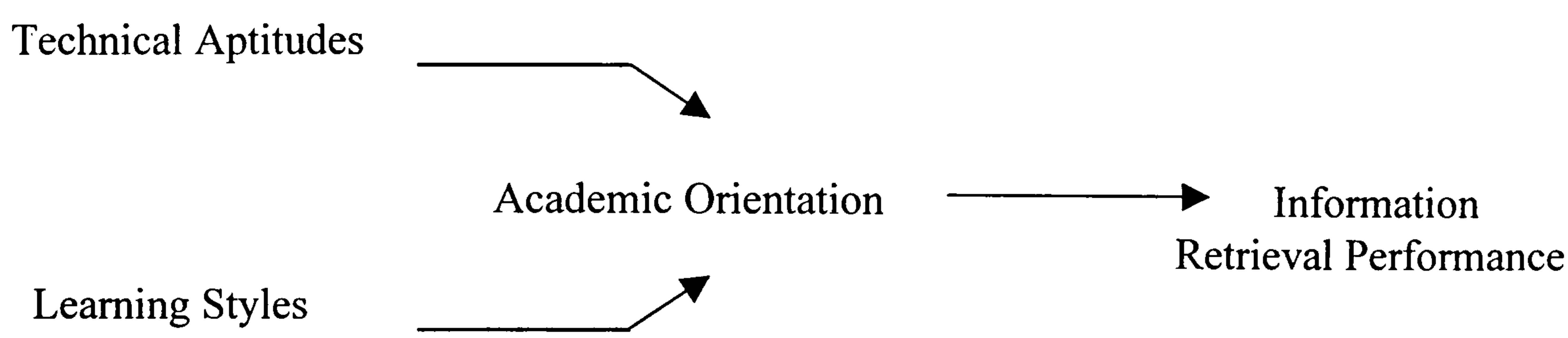
Logan (1990) also explored the relationship between on-line performance and preferences for learning methods and cognitive skills. Logan employed the LSI (described in Section 3.2.4) to identify the learning styles of 76 students undertaking a course in on-line searching at Florida State University's Graduate School of Library and Information Science. No indication is given as to the nature of the information retrieval system used in the study. The five measures of on-line performance used appear to be the same as those employed by Woelfl (1984). Although Logan's paper lacks the detailed description provided by Woelfl regarding the measures employed, there is sufficient similarity to assume they are the same. As the research focused on the process of information retrieval, no indication is given as to the significance of a high or low score on these measures. No outcome measures, such as precision and recall, were addressed.

The results from Logan's study found correlations between LSI measures and on-line performance. Those who were categorised as Accommodators and Assimilators, thus falling into opposite quadrants of the LSI grid (Section 3.2.4), were also shown to have opposing types of behaviour when undertaking an on-line search. The highest scores for on-line processes were achieved by Assimilators and the lowest by Accomodators. Assimilators spent more time on-line, issued more commands, keyed more descriptors, completed more cycles and printed more references than any other group. Accomodators had the lowest mean score on all measures except the number of descriptors keyed. Only Convergers had a lower mean score for this variable. Logan explains that the consistency between LSI placements and on-line search styles suggests a possible method of predicting a searcher's likely behaviour.

Borgman (1989) examined the learning styles and technical aptitudes which might be related to academic discipline after finding that academic discipline is related to information retrieval performance. Borgman employed the Myers-Briggs Type Indicator (MBTI) and the Learning Styles Inventory (LSI) (described in Sections 3.2.1 and 3.2.4, respectively). However, Borgman uses the term "personality characteristics" in referring to the learning styles identified by the MBTI and LSI. Therefore, it would seem that Borgman views learning style as synonymous with, or as an element of, personality (Section 3.1). The term learning styles will be used in reference to Borgman's work from here onwards in order to maintain consistent terminology throughout this thesis.

A hypothetical model formed the basis of the research which suggested that both technical aptitudes and learning styles lead to choice of academic discipline which, in turn, leads to information retrieval performance, as shown in Figure 4.1. Thus, academic discipline is used as an intervening variable to identify links to information retrieval performance (Balaraman, 1991).

Figure 4.1
A Hypothetical Model Of The Relationship Between Technical Aptitudes, Learning Styles, Academic Orientation And Information Retrieval Performance
Source: Borgman (1989)




A sample of 64 undergraduate students aged between 18 and 25 and studying one of three academic disciplines were chosen for the study. One academic major was selected to represent each discipline: engineering to represent science and technology; psychology to represent the social sciences and; English to represent the humanities.

Borgman (1989) found distinct differences between the learning styles of students undertaking different academic majors. The LSI (described in Section 3.2.4) identified the majority of engineering students as Convergers (Section 3.2.4) whilst the majority of English students were Divergers. These learning styles occupy opposite quadrants on the learning styles grid. Psychology students were equally divided between Divergers and Assimilators. The Converger style, displayed by engineering students, was similar to the styles of skilled searchers and programmers, suggesting a possible relationship between learning style, academic orientation and information retrieval. In reviewing the work of Borgman (1989) Balaraman (1991) notes that:

> *"... the style of thinking required for studying the sciences and engineering may be more appropriate for the use of computer-based information systems than that required for studying humanities and social science disciplines"* (p. 284).

However, the correlation between academic discipline and learning style was stronger when only subjects who had remained in one discipline were considered. Regarding the MBTI, only the thinking/feeling dimension was related to choice of academic major. These findings suggest that perhaps more research into the correlation between learning style and academic orientation is needed before the possibility of a transitive relationship between learning style and information retrieval performance may be established.

Balaraman (1991) draws on the findings of Borgman (1989) in a pilot study investigating the relationship between several variables and the performance of novice CD ROM searchers. The variables comprised: the system content; two levels of task (simple and complex) and; ten characteristics of the user. Regarding the system content, three CD ROM databases were employed. These comprised a science and technology index, a business periodicals index and a humanities index. No explanation of the nature of simple and complex tasks is provided by Balaraman. It has therefore been assumed that a differentiation is being made according to the level of difficulty involved in performing the task. Balaraman describes the user characteristics as including personality traits and learning styles measured using the MBTI and LSI respectively. This suggests that, in contrast with the view held by Borgman (1989), Balaraman views personality and learning style as different concepts. Balaraman considers the MBTI as a test of personality (Section 3.1). As stated earlier in reference to Borgman's work, the MBTI was identified in Section 3.2.1 as a measure of learning style and will continue to be determined as such to maintain consistent terminology. Search performance was determined by three dependent variables: the number of related hits; the time taken for the search and; the number of strategies/operators used. The influence of selected independent variables (namely computer affinity, personality trait, learning style, visual ability and sex) on choice of academic major was also examined in order to confirm or extend the findings of Borgman (1989).

The model proposed by Balaraman is illustrated in Figures 4.2 and 4.3.

Figure 4.2
Simple Tasks
Source: Balaraman (1991)

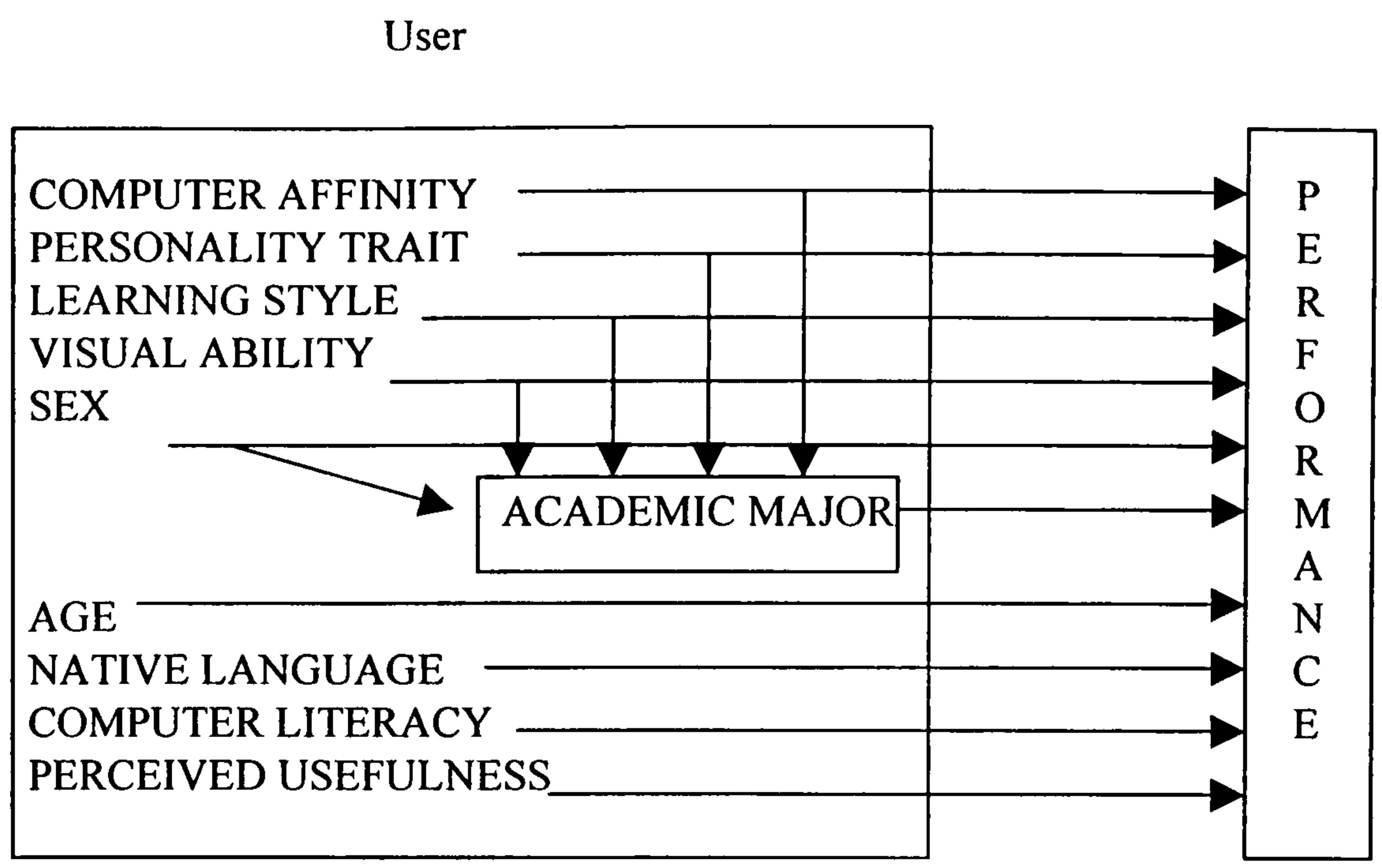
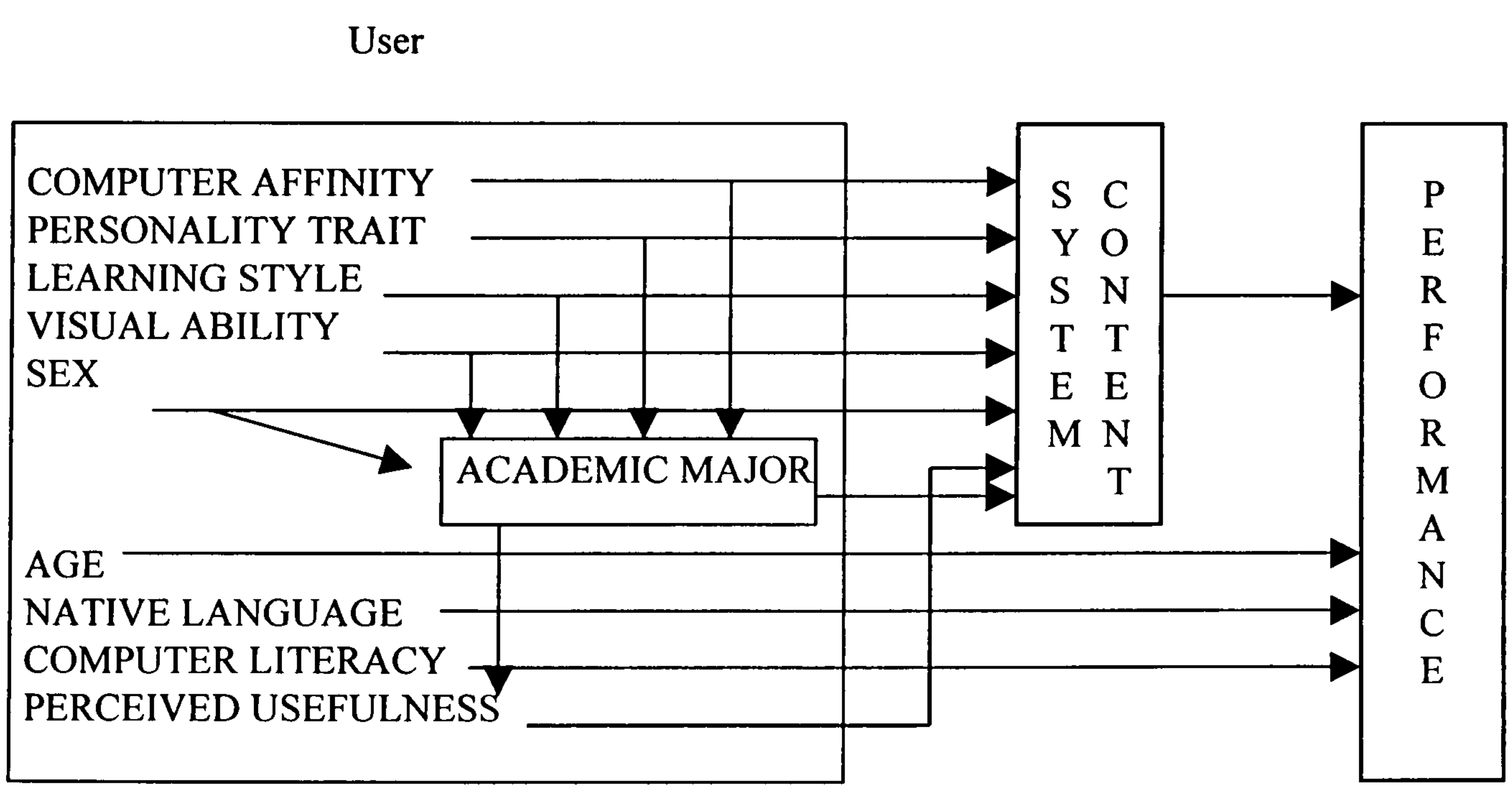



Figure 4.3
Complex Tasks
Source: Balaraman (1991)




As the nature of the research was a pilot study, only preliminary findings are given. However, a few conclusions were nevertheless drawn. A correlation between learning style and academic major was found for all of the styles identified by the MBTI (described in Section 3.2.1) except the judging/perceiving style. The thinking/feeling style was the only category of the MBTI in which a correlation between learning style and information retrieval performance was found. The LSI failed to show any link between learning styles and academic major or performance. These findings are in contrast with those of Borgman (1989), supporting the view that further research is needed regarding the influence of learning style on both academic major and information retrieval performance. Borgman's finding that information retrieval performance is related to both academic major and, by transition, learning style, is therefore inconclusive. Although the relationship between information retrieval performance and a variety of other factors was studied by Balaraman, the concern of this chapter is primarily with learning style. The reader is referred to Balaraman (1991) for an account of findings relating to other variables.

The studies reviewed thus far have employed existing information systems in researching the relationship between information retrieval and learning style. Ford and Ford (1993) argue that progress towards more effective and 'ideal' information retrieval systems is likely to be hindered by using existing systems to gain knowledge of searcher behaviour. This view is based on the fact that the technological limitations of current systems influence the research approach adopted, thus constraining the progress of research which is relevant to future, less inhibited, retrieval systems.

Ford and Ford (1993) conducted research which aimed to generate 'ideal' and more informed theories of human-computer interaction. The research sought to employ an information retrieval system which would not be subject to the limitations of existing computer-based systems, being capable of the sort of flexible response to queries characteristic of a human expert. As no such system existed, the Diogenes system was built especially for the purpose of the research. Diogenes was able to observe and record users' interactions and was designed to *"communicate with users freely, in natural language, and to respond intelligently and helpfully to any request for information, no matter how it was phrased*" (p. 570). It also provided expert knowledge of the relevant subject matter and allowed students to adopt information accessing strategies of their choice. Incorporating such advanced features within the system was possible through the system's "ideal" knowledge base which consisted of two human experts.

30 volunteer postgraduate Librarianship and Information Science students took part in a study which required information to be retrieved in order to learn how to index using the PRECIS document indexing system. The human experts communicated with users via computer terminals and were supported by appropriate documentation and computer files. The users were unaware that they were interacting with the human experts. This prevented information seeking strategies being affected by factors such as embarrassment over ignorance, slowness of interaction and differing expectations or assumptions. Knowledge of the experts would also defeat the objective of the research: to investigate users' interactions with a perceived computer system in order to gain data of use in the development of future computer-based information systems.

Retrieval effectiveness was defined in terms of the students' understanding of the information gathered regarding the PRECIS system. This was measured by a questionnaire given to students after completing the exercise. As the information retrieved was directly linked to the user's understanding, maximum retrieval effectiveness would result in maximum learning efficiency and vice versa. Two successful information accessing strategies emerged from the research. The first, and most, successful strategy was characterised by those students who undertook a relatively passive intake of information coupled with an attention to detail. The second successful strategy was characterised by relatively active behaviour, concentrating on higher level, overview material and conceptual issues rather than details. Ford and Ford (1993) liken these approaches to the 'operation learners' and 'comprehension learners' identified by Pask (1976) and described in Section 3.2.6. Although the students adopted different information accessing strategies, each strategy proved effective in terms of the learning objective. The principal route to failure was characterised by those focusing on middle-level subject matter and procedural detail. Section 3.2.6 identified a third learning style proposed by Pask: that of versatile learners. However, Ford and Ford (1993) suggest that although the two successful strategies may be likened to the approaches of operation and comprehension learners, the unsuccessful strategy cannot be likened to the approach of versatile learners. Versatile learners are able to combine an overview of the material with detail to achieve effective learning. The third approach observed by Ford and Ford (1993) may have been unsuccessful because the students were able to gain neither an overview nor detail of the material, therefore falling between the two successful strategies.

As Hypertext and Hypermedia become more widely used, the relationship between learning style and information retrieval from systems incorporating these concepts has also been investigated. Hypertext may be defined as:

> *"A generic term covering a number of techniques used to create and view multi-dimensional documents, which may be entered at many points and which may be browsed in any order by interactively choosing words or key phrases as search parameters for the next text image to be viewed ..."* (Dictionary of Computing, 1996).

Hypermedia may be defined as:

> *"An extension of Hypertext to include multimedia, i.e. graphics, video, and audio as well as textual material"* (Dictionary of Computing, 1996).

A study by Ellis, Ford and Wood (1993) evaluated Hypertext learning systems in terms of the extent to which they provide flexibility for learners to follow their preferred learning styles. Experiments were undertaken with two packages. The first package, relating to "1992": the Single European Market, was tested with postgraduate MBA and Information Studies students. The second package related to the field of food and wine and was tested with higher education students enrolled on a catering course. Students were assessed for tendencies towards Field-Independence, Field-Dependence, Holism and Serialism. Students used the Hypertext packages to answer a set of questions and were assessed in terms of factual recall and 'teachback' of what they had learned.

Results showed that Serialists consistently scored more correct answers than Holists even though there was no significant difference in the number of successfully located facts. Ellis, Ford and Wood (1993) propose that this finding may indicate that Serialists are more successful in recalling factual data. Alternatively it may be that Serialists were more able to gather needed information more opportunistically in the briefing sessions given. However, although Serialists were more successful in recalling information and achieved a higher overall score for correct answers, they also attempted more questions and so had a greater chance of scoring more correct answers. Holists answered fewer questions but with greater accuracy. A similar pattern emerged for the Field-Dependent/Field-Independent groupings where Field-Dependent students were less successful in producing correct responses.

Data regarding the use of navigational and retrieval tools showed distinctly different approaches between cognitive style groups. Serialists made greater use of the index: a tool which is suited to finding specific information. Holists made greater use of the more global diagrammatic map of the system: a tool which allows the user to keep track of where s/he is in relation to the overall structure of the subject matter. No statistically significant differences were found in the preferences for particular tools between Field-Dependent and Field-Independent students. However, Field-Independent students accessed more documents, and in many cases the same document was returned to several times. Ellis, Ford and Wood (1993) suggest that perhaps these students need to access a larger number of documents to achieve the same degree of accuracy of response.

No evidence was found which connected different approaches to learning with performance. All students created individual strategies successfully using tools they felt comfortable with, to achieve largely similar end results. Ellis, Ford and Wood (1993) suggest that cognitive styles may not *"enforce a particular style of usage upon a particular individual"* (p. 17). The impact of cognitive style on information behaviour may be constrained by other factors such as the speed with which an individual learns to use the system. Therefore, providing a variety of tools for use within the Hypertext environment allows the user to evolve a strategy for effective performance.

Research by Liu and Reed (1994) examined the different learning strategies of 63 college students within a Hypermedia-assisted instructional setting. The investigation sought to identify the relationship between learning styles and patterns of learning and; which types of media, tools and learning aids were most preferred by different learning style groups. The Group Embedded Figures Test (GEFT) (Section 3.2.2) was employed to determine Field-Dependent or Field-Independent learning styles.

The students were all studying to improve their English language skills before beginning a degree programme. The research was undertaken in a language learning environment using Voyager's Citizen Kane videodisc as the context in which the language would be taught. The courseware consisted of four sub-programs, each concentrating on one part of Kane's life and teaching 20 words. A total of 80 words were therefore included in the courseware. When the movie was shown, the text was presented on the screen with the taught words highlighted. Participants could choose any of these words and view: the definition (in either text or graphic format); a part of the speech, together with the definition of the word; different sentences in which the word was used; the context of the vocabulary use through video media and; information on word usage, synonyms, and antonyms to gain an understanding of the relationship of the word to other words. Data was gathered regarding the following aspects.

- Total amount of time spent using the courseware.
- Total number of times the courseware was used in terms of the number of times a participant went back to the beginning of the courseware after initial use.
- Total number of times different media were accessed in terms of text, video and graphic media.

- Total number of times each tool was accessed. Tools included: index; on-line help (which provides explanation of the icons used in the software); map (which provides the structure of the courseware, the current location of a participant and the options used); notetaking, and; follow-up exercise tools.
- Total number of times different learning aids were used. Learning aids included definitions of words; part of the speech; sentence examples; video context and; the relationship of words to other words (i.e. synonyms and antonyms).
- Total number of times the mini-dictionary was used. The mini-dictionary provided the facility for looking up any of the words in the main text as well as the 80 target words.
- Number of times the courseware's background information was used. Background information included notes on such topics as the American presidential campaign and American newspapers.

Differences in the learning strategies used by both Field-Independent and Field-Dependent students were found. Field-Dependent students used the courseware more times, and for longer periods than Field-Independent students. Although there was little difference between Field-Dependent and Field-Independent students in the use of text and graphics media, Liu and Reed (1994) report that Field-Dependent students favoured video media more. However, each occurrence of using the courseware resulted in the students watching video clips. As Field-Dependent students used the courseware more, it is unclear whether greater usage of video results from this behaviour or from an apparent preference for the media type. However, a preference for video media is also reflected in the types of learning aids used. Field-Dependent students chose the video context option, whilst Field-Independent students chose to view the relationship of words to other words. The relationship option, provided the most complete and detailed textual information on the use of the word including definition, parts of speech, sentence examples, synonyms and antonyms. Students who were Field-Mixed chose sentence examples, this learning aid being in between the relationship option and the video context option. In learning the vocabulary, Field-Dependent students followed the sequence provided by the courseware, whereas Field-Independent students tended to jump about, manipulating the courseware without following a set sequence. The index tool provided the means to look at a particular word without going through the usual sequence in the video clips, allowing the user to look at examples of word use earlier in the clip before returning to the previous place. Field-Independent students used this tool more than Field-Dependent students showing an ability to manipulate the courseware without getting lost. There was little difference between Field-Dependent and Field-Independent students regarding the use of the exercise tool, the notetaking tool (although Field-mixed students used this three times as much as other groups), the on-line help or map tools.

It can be seen that Field-Independent students chose a more analytical method of learning the words, whilst Field-Dependent students chose a more global, or contextual approach. However, although students with differing styles chose differing approaches involving different media, tools and learning aids, they performed equally well in terms of achievement in learning the required vocabulary.

Leader and Klein (1994) investigated the effects of interface tools and cognitive styles on the performance of students in searching for information within the EarthQuest Hypermedia database. EarthQuest is designed for social studies and science instruction, containing information on earth science, invention and politics, ecological issues, and geography. The information is presented on over 80 screens by text, graphics, animation, and sound. EarthQuest provides five basic facilities comprising: buttons for viewing graphics or text; a find feature allowing the database to be searched for text strings; an index listing the contents of the database; maps displaying a hierarchy of the database content, which can be searched to find information and; a browser to navigate between screens of the same, or different levels in the content hierarchy. Cognitive styles were again assessed in terms of Field-Dependence and Field-Independence using the Group Embedded Figures Test (GEFT) (Section 3.2.2).

75 adult students participated in the study, being randomly assigned to one of four treatments involving the five basic tools provided by EarthQuest. A selection of tools were disabled

according to the particular treatment. The Browser treatment had the index, find and map tools disabled; the Index/Find treatment had the browser and map tools disabled; the Map treatment had the browser, index and find tools disabled. The All Tools treatment was unmodified.

Search performance (measured by the accuracy of both the ability to locate information and the content of that information), patterns of tool use and participant attitudes were investigated. It was expected that different cognitive style groups would use the four levels of search tool (browser, index/find, map and all tools) with varying effectiveness depending on the ability of the tool to provide the correct type of environment for each of the cognitive styles.

Findings indicated that Field-Independent students showed higher search achievement in the Index/Find and Map treatments. Leader and Klein (1994) explain that as the Index/Find treatment required an active approach which is suited to the Field-Independent cognitive style, this finding was expected. However, higher achievement by Field-Independent students in the Map treatment was unexpected, the holistic nature of the maps being more suited to Field-Dependent students. Leader and Klein explain that as maps were not available for every screen, students assigned to this treatment were required to perform additional operations, unrelated to the context of the current search, to reach their desired information. Therefore, the findings suggest that Field-Independent students were able to do this with greater efficiency having the ability to "transfer concepts to new concepts". No significant difference was found between Field-Dependent and Field-Independent students in the Browser and All Tools treatments. However, the fact that students assigned to the All Tools treatment made predominant use of the browser tool accounts for the similarity in performance between these two treatments.

Regarding patterns of tool use, Leader and Klein (1994) report that Field-Independent students accessed more screens whilst using their treatment tools than Field-Dependent students, supporting the suggestion that Field-Independent students were more actively engaged in searching the database. Results from the attitude survey found that whilst all students agreed that EarthQuest was a good program, Field-Dependent students provided more positive feedback than Field-Independent students.

### 4.2 A Critical Analysis Of Previous Research

Research into the influence of learning style on information retrieval from ELS would benefit from an insight into the relationship between learning style and information retrieval from other systems. For example, which aspects of information retrieval are influenced by learning style. Whilst insight may be gained from individual studies reviewed in Section 4.1, drawing conclusions based on collective findings is difficult. Some studies indicate a possible influence, others do not. Thus, the nature of the relationship remains unclear.

Comparing the findings of the research reviewed in Section 4.1 is inhibited by various differences between the studies. As stated in Section 3.1, differences in the perception of learning style are apparent in the work of both Borgman (1989) and Balaraman (1991). Section 3.2 identified the LSI and MBTI as measures of learning style. However, Borgman (1989) views these instruments as measures of personality. Borgman provides no definition of the term "personality" or indication of the context in which it is being used. It is therefore unclear whether Borgman perceives learning style as synonymous with personality, as an element of personality, or as an entirely different concept. In building on the work of Borgman (1989), Balaraman (1991) adopts a different view, using the LSI to measure learning style and the MBTI to measure personality. This indicates that Balaraman views learning style and personality as different concepts. Again, no definition of these terms is provided. Within the present research learning style is viewed as one element of an individual's personality (Section 3.1).

There are also differences in the sample sizes used between studies and, more significantly, in the construction of the sample itself. For example, Borgman (1989) chose students from three academic disciplines, Ford and Ford (1993) chose postgraduate library and information science students and Palmer (1991) chose researchers working in essentially science oriented occupations at an agricultural research station. The variability in the samples used makes comparisons between the studies difficult. For instance, there may be characteristics connected with postgraduate students which interact with learning style to influence information retrieval. These characteristics may not be present in agricultural researchers.

Differences in outcome measures are also apparent. Balaraman (1991) used a combination of three measures to determine performance: the number of related hits; time taken for the search and; the number of strategies/operators used. Ford and Ford (1993) defined retrieval effectiveness in terms of the subject's understanding of what had been retrieved whereas Saracevic et al. (1988) used measures of relevance, precision, and recall. Logan (1990) employed five measures of on-line performance, these being: cycles, commands, descriptors, connect time and references.

The studies reviewed in Section 4.1 also demonstrate differences in both the research objectives and the type of information system employed. For example, research has investigated correlations between learning style and the search outcome, in terms of precision and recall; correlations between learning style and the search process, in terms of tool use; the ability of systems to support various searching styles; and correlations between searching styles and learning outcome, in terms of the amount learned. The information retrieval systems employed in the research include CD ROM and other bibliographic databases, Hypertext and Hypermedia systems and the Diogenes system, built especially for the purposes of research by Ford and Ford (1993).

More consistency is apparent in the findings of research undertaken within a Hypertext or Hypermedia environment. These studies use similar measures of learning style, similar systems and measure similar outcomes. Although the content of each system was based on differing software and designed for different purposes, the descriptions of the operational tools show that each system incorporated similar functionality. Each study also considered patterns of tool use allowing findings regarding search strategies to be compared. Liu and Reed (1994) and Leader and Klein (1994) both employed the GEFT (described in Section 3.2.2) in measuring Field-Dependent and Field-Independent learning styles. Although Ellis, Ford and Wood (1993) employed the Short Inventory of Approaches to Studying (described in Section 3.2.6), Field-Dependent and Field-Independent styles were considered together with Holism and Serialism. The studies also show consistency in the research samples used, all of which comprised students. Because of the similarity in approach, findings from the Hypertext/Hypermedia studies may be more reliable than those of other studies, and may therefore be of greater use in assessing the relationship between learning style and information retrieval behaviour. Findings from these studies indicate that learning style may be an important determinant of the way in which a search is conducted. It appears that some students are predisposed towards gaining an overview of the material before adding detail, whilst others prefer to gain detailed information before adding structure and sequence. However, an influence on the search outcome was not found, each strategy proving to be equally effective in gathering the required information.

**Summary**

This chapter explored existing research into the relationship between learning style and information retrieval. The literature reveals little of substance on which to build research within the ELS environment. Whilst some researchers have found learning style to be a significant aspect of information retrieval, others have not. The Hypertext/Hypermedia studies perhaps provide the greatest indication of the relationship between learning style and information retrieval behaviour. Findings from these studies suggest the provision of facilities for both broad and detailed approaches to information gathering are of particular importance in supporting the activities associated with different learning styles. This supports the view that the influence of learning style requires consideration when designing information retrieval systems such as ELS. Chapter 5 describes the objectives of the present research which investigates the relationship between learning style and information retrieval from an example ELS.

# CHAPTER 5

## THE PRESENT RESEARCH: AIMS AND OBJECTIVES

Chapter 4 described research which sought to find a relationship between cognitive/learning style and information retrieval from a variety of systems. It was hoped that conclusions from these studies would be of use in researching the influence of learning style on information retrieval from ELS. However, the conclusions have proved less than adequate in this respect. The present chapter describes the aims and objectives of research which develops an understanding of the relationship between learning style and information retrieval from an example ELS. The rationale for the choice of ELS and learning styles instrument employed in this research is provided in Sections 5.2 and 5.3, respectively. Section 5.4 details appropriate measures for exploring the relationship between learning style and information retrieval and; the ability of ELS to support the information retrieval activities of different learning style groups. Section 5.5 offers insight into the differing viewpoints surrounding learning styles research and provides clarification of the perspective taken within the present research.

### 5.1 Aims And Objectives

The primary aim of this research is to ascertain whether a relationship exists between learning style and information retrieval from ELINOR, an example ELS. A detailed description of ELINOR was given in Section 2.3. If learning style is found to influence information retrieval from ELINOR, then the research may indicate that learning style requires consideration in the design of ELS of similar description. Conversely, if little influence is found, the findings may suggest that learning style does not require consideration when designing similar ELS. The phrase 'similar description' refers to any system whose content comprises written documents. It cannot be assumed that a similar relationship exists between learning style and information retrieval from systems based on different criteria.

The research also investigates whether ELINOR can support the information retrieval activities associated with different learning styles. The research is based on the premise that the functionality which provides facilitation for each learning style will combine to prescribe the functionality necessary to facilitate the information retrieval activities associated with all learning styles. Findings will assist in prescribing the functionality necessary within ELINOR (or indeed any ELS of similar description) to facilitate information retrieval by different learning style groups over the range of tasks included within this research. This will aid in designing ELS which are effective in meeting the requirements of target users. However, it cannot be assumed that users will have similar requirements for systems based on different criteria. The functionality which supports the information retrieval of those using ELINOR may not support information retrieval within an ELS whose content is based on, for example, photographs. The term 'functionality' refers to both the document content of ELINOR and its operational facilities. 'Document content' refers to the number and nature of documents (for example, books, journals, lecture notes etc.) contained within ELINOR. The term 'operational facilities' refers to the set of commands which may be given by the user to allow operation of ELINOR's computer program. An operational facility is defined as:

> *"any aspect of ELINOR's interface which allows the user to initiate an action, process or operation, usually by selection of an icon or menu."*

The two major research questions addressed within this thesis are therefore stated as follows.

> *Does learning style influence patterns of information retrieval from ELINOR for simple and complex tasks?*
>
> *Can ELINOR's functionality support the information retrieval activities of different learning style groups for simple and complex tasks?*

## 5.2 Selecting An ELS For The Research

ELINOR was chosen as an example ELS for several reasons. Firstly, a sample of students from De Montfort University was asked to participate in the research by using the ELS

(Section 6.5). As ELINOR was available for use at De Montfort University it provided a convenient system in terms of location. Secondly, ELINOR was developed by De Montfort University. For the author to gain a thorough working knowledge of the system, immediate access to the expertise of those who had developed the ELS was desirable. Collaboration with those responsible for maintaining the ELS was also necessary to ensure the functionality of the ELS remained constant during the period of practical research. If the system's design were to change, inconsistencies in the operational facilities or documents available to participants may introduce bias within the research findings. Thirdly, ELINOR is one of the first large scale electronic library projects in the UK. Therefore, ELINOR has been well researched and presents a fully-developed, working system. Previous research (reviewed in Section 4.1) suggests that learning style may influence the choice of searching and browsing facilities within Hypertext and Hypermedia systems. As ELINOR provides similar facilities, its use within this research also provides the opportunity to explore this outcome further.

Section 5.1 stated that the influence of learning style on information retrieval and user requirements may differ between systems based on different criteria. ELINOR's content is based on the full-text of documents. Therefore, the outcome from this research may not be applicable to ELS whose content is based on, for example, photographs. However, a major aim of all ELS is to reduce the need for libraries to store physical documents. As the majority of documents academic libraries are required to hold are text-based, the majority of ELS developed are also likely to be text-based. Therefore use of ELINOR as an example ELS within this research is highly appropriate. Furthermore, the majority of information retrieval systems employ search techniques similar to ELINOR's Search facility whereby the text within documents is matched to a query supplied by the user (Section 2.3.3). Information retrieval systems, such as those based on Hypertext or Hypermedia, may also employ facilities similar to ELINOR's Fileroom facility. Hence, the major aspects of ELINOR's functionality are representative of those employed by many information retrieval systems. Therefore, the research outcomes will also be applicable to a wide variety of systems, other than ELS.

## 5.3 Selecting An Instrument For Measuring Learning Styles

Selection of an instrument for measuring learning styles was dependent on a number of requirements. Firstly, it was desirable that the instrument show both validity and reliability in its construction. Validity refers to the extent to which the instrument measures learning style (Tyler, 1971). Reliability refers to the extent to which the instrument is accurate or consistent in its measurement of learning style (Tyler, 1971). Secondly, the instrument needed to be quick and easy to administer and interpret, requiring no expert knowledge. Finally, a self-report inventory was sought, allowing the instrument to be completed by large numbers of people at the same time. Although there are many instruments which have been developed to identify learning styles (Section 3.2), it was decided to adopt one only. Whilst comparison of results from two or more learning style instruments would prove interesting, it was not feasible to apply more than one instrument within the research. Asking participants to complete several instruments in succession raises questions of validity, as answers given to one instrument may influence answers to subsequent instruments.

The Learning Styles Questionnaire (LSQ) (described in Section 3.2.5) proved the most appropriate measure to adopt for the research. The LSQ fulfils the requirements of being a self-report inventory, being quick to administer with no expert knowledge for interpretation and having no restrictions on its use. The ability to copy freely the LSQ provides a further advantage. Instructions for using and interpreting the LSQ are well documented. A clear description of the characteristics associated with each of four learning styles (summarised in Table 3.4) is also provided. A further factor in choosing the LSQ was its immediate availability to the author.

Honey and Mumford (1992) found the reliability and face validity of the LSQ to be high. Face validity refers to the degree to which the test-taker sees a test as being reasonable and appropriate for a given situation (Bartram, 1990). Face validity has practical significance in aiding co-operation between the test-taker and the test administrator. People are more likely to take seriously activities which seem reasonable and which they feel they understand. In turn, this may increase the reliability of the test. Allinson and Hayes (1990) compared the LSQ with the LSI (Section 3.2.4) and found evidence of both face validity and construct validity within the LSQ. Construct validity refers to the extent to which a test measures what it is supposed to measure (Bartram, 1990). However, the LSQ's predictive validity was doubtful. Predictive validity refers to the extent to which scores from a test can be used to predict future performance (Bartram, 1990). Allinson and Hayes (1990) therefore suggest care is taken in interpreting the results until the predictive validity has been satisfactorily established. However, this is not considered problematic within the present research. The LSQ not only identifies the type of learning style preferred by individuals, but also the strength of that preference. It also identifies instances in which there is an equal preference for more than one learning style (Section 3.2.5). Only participants with a strong or very strong preference for one learning style were selected for participation within the present research. This provided a clear distinction between learning style preferences, minimising uncertainty regarding the predictive validity of the LSQ. The selection of participants is discussed further in Section 6.5.

## 5.4 Selecting Suitable Outcome Measures For The Research

The relationship between information retrieval and individual characteristics, such as learning style, has often been assessed in terms of search outcome, using measures such as precision and recall (Hsieh-Yee, 1993). A definition was provided for both these terms in Section 2.5. However, Borgman (1996) suggests that comparing differences in search outcome is not a suitable method for investigating information retrieval behaviour. She states that:

> *"Searching information retrieval systems is a highly interactive, iterative process that cannot be understood simply by comparing the output of a search session (the "search product") to a query stated in advance"* (p. 568).

Borgman (1996) suggests that greater knowledge about the actual search process is necessary to realise the potential of sophisticated and effective information retrieval systems. Evaluation methods which can capture the search process and *"support fine-grained analyses of searching behaviour"* (p. 568) are required in order to gain this knowledge. Such methods include transaction log analysis (TLA), the method adopted within this research (Section 6.8.1).

It is also difficult to determine exactly what the user requires in terms of the search outcome. As Salton (1992) explains:

> *"The main assumption behind the use of measures such as recall and precision is that the average user is interested in retrieving large amounts of relevant materials (producing a high recall performance), while at the same time rejecting a large proportion of the extraneous items (producing high precision). These assumptions may not always be satisfied"* (p. 442).

For example, Su (1994) explains that for those who expect to find only a few references, low precision may suffice. Alternatively, users may prefer to have few, highly relevant, references than a large number of less relevant references. A greater understanding of user preferences is necessary before outcome measures, such as precision and recall, can be used with accuracy in assessing the relationship between individual characteristics and information retrieval.

The search process was investigated by Ellis, Ford and Wood (1993), Liu and Reed (1994) and Leader and Klein (1994) using systems comprising similar functionality to ELINOR. The findings of these studies (described in Section 4.1) suggest that the search processes employed by different learning style groups requires further examination.

It is for these reasons that the present research focuses on the process or *patterns* of retrieval associated with user groups with differing learning styles when performing a range of tasks. A pattern is defined as *"a standard way of moving, acting"* (Collins Softback English Dictionary, 1991). The research is therefore concerned with the actions performed rather than the outcome achieved. The patterns of information retrieval associated with different learning style groups are assessed in terms of the number and nature of both documents and operational facilities used. The term "nature" refers to the range or number of different types of document and operational facility used. As stated in Section 5.1, different types of document include books and journals. Examples of different types of operational facility include those which allow a window to be dismissed or an image page to be viewed. Section 2.3 explained that, in several instances, ELINOR provides alternative facilities for performing the same operation. For example, a window may be dismissed by selecting either a menu or button. For the purposes of this research all operational facilities are considered to be different from one another. The number and nature, or range, of operational facilities used will therefore be the same.

The ability of ELINOR to support the information retrieval activities of different learning style groups is assessed in terms of the extent to which each group is constrained by ELINOR when completing a number of tasks. Individuals within each learning style group were asked to indicate their attitudes towards the number and nature of documents and operational facilities contained within ELINOR. This information was used in prescribing the functionality necessary within ELINOR to support information retrieval by different learning style groups over the range of tasks included within this research.

## 5.5 Learning Styles Research: Alternative Viewpoints

This section provides an insight into the differing viewpoints surrounding learning styles research and provides clarification of the perspective adopted within the present research.

Honey and Mumford (1992) suggest that most people are unaware of their learning style preferences: *"they just know vaguely that they feel more comfortable with, and learn more from some activities than others"* (p. 2). In order to make learning effective, the learning event should be sufficiently in line with an individual's preferred learning style (Williams, 1987). Hence, an understanding of the situations in which an individual is likely to learn most effectively can be very beneficial. As one of ELINOR's objectives is to facilitate learning, such an understanding would seem highly beneficial. Moran (1991) argues that the assumption that learning styles can be matched with teaching styles has contributed to both theoretical and methodological difficulties for researchers in the field. The research described in this thesis does not aim to match learning styles and teaching styles. Furthermore ELINOR cannot be seen as an instrument for teaching. A teacher may be defined as *"a person whose profession, or whose talent, is the ability to impart knowledge, practical skill, or understanding"* (The Chambers Dictionary, 1994). ELINOR provides access to material which may be used in the process of teaching, but does not carry out actual academic instruction.

Moran (1991) argues that a variety of other factors have caused both theoretical and methodological difficulties for learning styles research. These factors include: firstly, the assumption that people differ consistently in their preferences for methods of processing information and secondly, the assumption that individual differences are measurable. It is beyond the scope of this research to assess the extent to which differences in learning styles are measurable or consistent among individuals. Many instruments have been developed which identify differences in learning style, a selection of which were described in Sections 3.2.1 to 3.2.6. The very existence of these instruments and their wide usage suggests that differences *are* consistent and measurable. Indeed, the success of such instruments is dependent on confirmation of this. Moran (1991) also states that little research has been conducted into the construct validity (defined in Section 5.3) of learning style instruments. Extensive research is required in order to assess the construct validity of the many instruments available for identifying learning styles. Such research is outside the scope of the present investigation. The LSQ presents sufficient construct validity for the purposes of this research (Section 5.3).

A variety of authors, for example Honey and Mumford (1992), view learning style as a characteristic inherent within any individual which operates independently of context. An alternative viewpoint is that the learning style adopted by an individual is dependent on the context or environment in which learning takes place. Hence, differences in learning style are dependent on the student's interpretation of the learning environment (Laurillard, 1979). This interpretation may be based on factors such as the nature of the subject matter, the approach required for the task and workload. A further factor may be related to what is required in order to gain reward: a deeper understanding of the subject matter or simply the ability to reproduce information. Within the present research learning style is viewed as being one element of an individual's psychological profile, sufficiently deep-seated to operate independently of context. Furthermore, the context within which information retrieval took place was consistent for all participants and factors relating to the learning environment were not expected to influence the research outcome.

**Summary**

This chapter described the aims and objectives of research which develops an understanding of the relationship between learning style and information retrieval from an example ELS. ELINOR is highly appropriate as an example ELS. It fulfils the research requirements in terms of its availability for use and access to the expertise of its developers and those responsible for maintaining the system. ELINOR also presents a working ELS which comprises functionality representative of that employed by many information retrieval systems. Therefore, the research outcomes may be applied to a variety of systems other than ELINOR. The LSQ was adopted for identifying learning styles. The LSQ satisfies the research requirements in terms of reliability, validity, ease of administration and availability.

The research investigates the influence of learning style on information retrieval patterns. The extent to which ELINOR's functionality can support the information retrieval activities of different learning style groups is also examined. Findings will indicate whether learning style requires consideration in the design of future ELS and assist in prescribing the functionality necessary to support information retrieval by different learning style groups over the range of tasks included within this research. This will aid in designing ELS which are effective in meeting the requirements of target users. Chapter 6 describes the research methodology employed in gaining the data required for answering the research questions stated in Section 5.1.

# CHAPTER 6

## RESEARCH METHODOLOGY

Chapter 5 described the aims and objectives of the present research with regard to developing an understanding of the relationship between learning style and information retrieval from an example ELS. In order to fulfil the research objectives, data regarding the patterns of use and attitudes of different learning style groups towards ELINOR was required. The present chapter describes the research methodology employed in gaining this data. Section 6.1 provides an overview of the methodology whilst Sections 6.2 to 6.8 inclusive describe the various stages employed. Specifically, Section 6.2 describes the target population chosen for the research whilst Section 6.3 details the identification of learning styles. Measures to counter the possible influence on the research outcome of differences in characteristics other than learning style, are described in Section 6.4. Sections 6.5 to 6.8 detail the methods employed in selecting a sample of students for participation in the research, their training in the use of ELINOR, the range of tasks over which patterns of information retrieval were explored, and the methods of data collection.

### 6.1 An Overview Of The Research Methodology

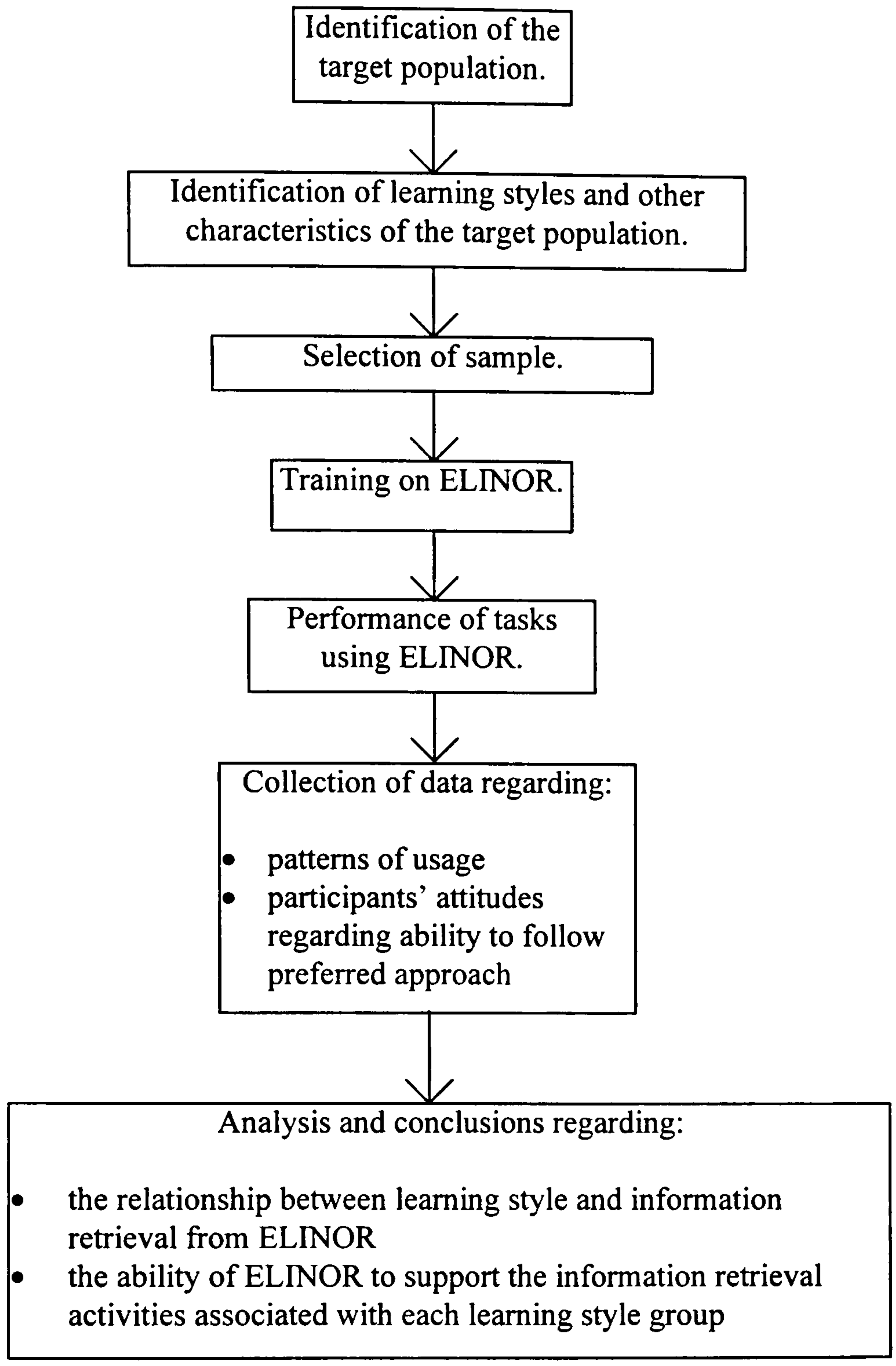
Antill (1985) explains that choosing an appropriate methodology for information systems research is a difficult task. Due to the nature of information systems, any investigation will combine aspects from several disciplines and will require the employment of a variety of research methods. Galliers and Land (1987) propose a taxonomy of approaches to information systems research. The research methodology described in this chapter is in agreement with their recommendations. The methodology also contains elements of research methodologies previously employed in researching the relationship between learning style and information retrieval. This research was described in Section 4.1. The approach taken within this research is quantitative. Questionnaires were employed in ascertaining learning styles (Section 6.3), demographic characteristics (Section 6.4.2) and attitudes of students towards ELINOR

(Section 6.8.2). A logging system (described in Section 6.8.1) was employed in gathering statistical data regarding the number and nature of documents and operational facilities used by learning style groups when undertaking tasks using ELINOR. Hypotheses are proposed and investigated by examining relevant summaries of data (Chapter 8). Confidence intervals (defined in Section 8.1) were employed in making inferences about the information retrieval behaviour associated with different learning style groups. However, the methodology also includes more qualitative methods of inquiry in the form of interviews (described in Section 6.8.3) to aid interpretation of the statistical data gained from the evaluation questionnaire and assess the suitability of the research methodology.

A target population for the research was identified and the learning styles of individuals within it ascertained. Data regarding a variety of other characteristics was also recorded in order to assess the influence of factors other than learning style on the research outcome. A sample of students from the target population undertook training and tasks using ELINOR. The use of documents and operational facilities in each task was recorded in order to assess the relationship between learning style and patterns of information retrieval. Participant attitudes regarding the ability of ELINOR to support information retrieval were also recorded in order to assess the functionality necessary to facilitate information retrieval by each learning style group. Conclusions (discussed in Chapter 9) will aid the design of ELS to make them more effective in meeting the requirements of target users.

A diagram illustrating the various stages of the methodology is shown in Figure 6.1. Details of specific activities associated with each stage are given in Sections 6.2 to 6.8 inclusive.

Figure 6.1
Overview Of The Present Research




## 6.2 Target Population

The target population for the research comprised undergraduate students undertaking courses within the School of Computing Sciences at De Montfort University, Leicester. This target population was chosen for two reasons. Firstly, ELINOR was developed for use by students at De Montfort University. Secondly, at the time the research was undertaken, computing texts comprised one of the largest subject areas within ELINOR. Students at the Leicester campus were chosen to avoid differences in the use of ELINOR biasing the research outcome. As ELINOR is currently available only to students at the Milton Keynes site, it was assumed that no students at the Leicester campus would have prior knowledge of the system. Training ensured that each student had the same level of ability in using ELINOR (the training process is described in Section 6.6). Targeting students at De Montfort University also facilitated contact regarding participation in the research. Had students at an alternative location been used, such contact would have been difficult to attain.

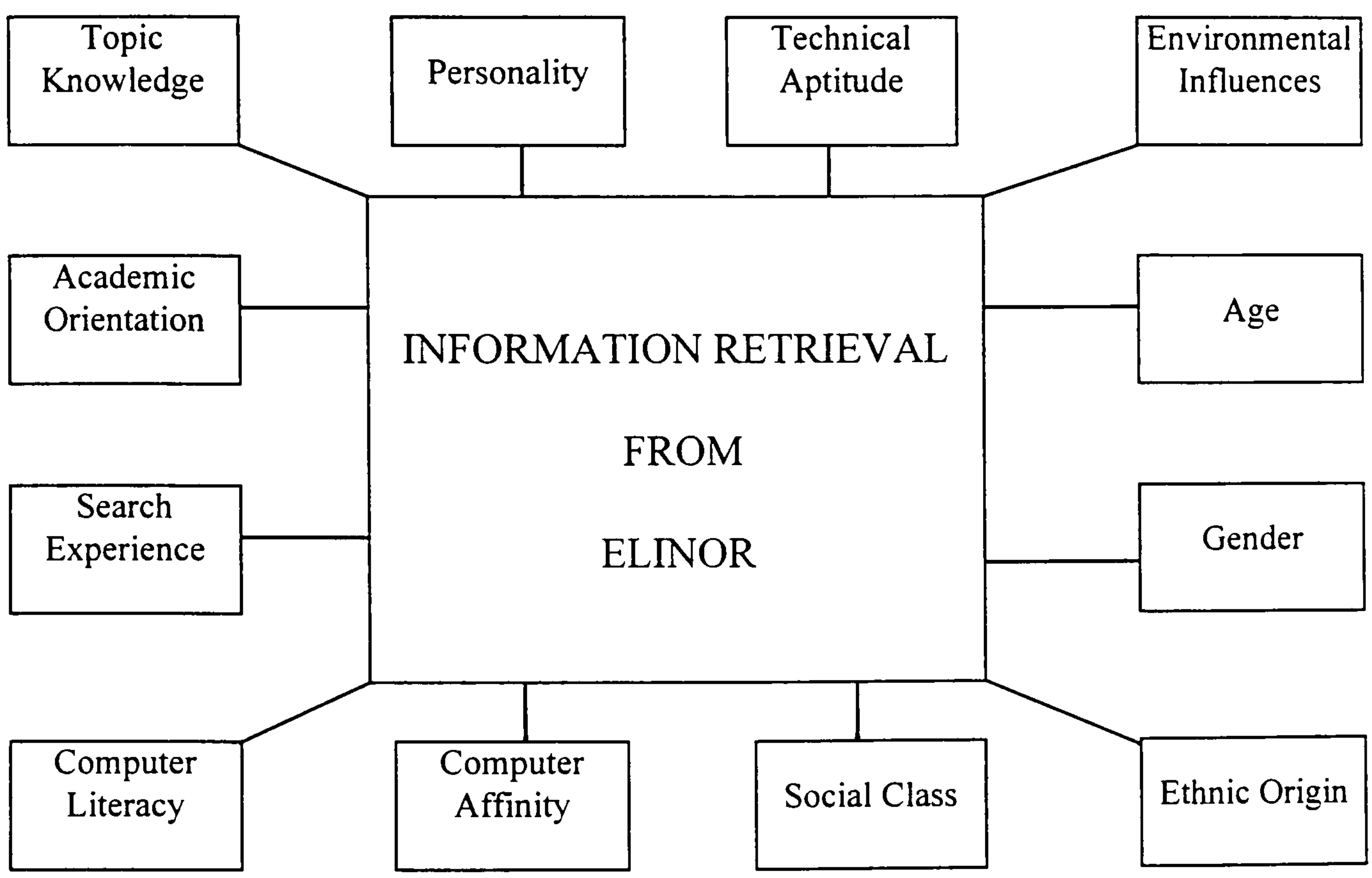
## 6.3 Identification Of Learning Styles

In order to identify the learning styles of the target population, students were asked to complete the Learning Styles Questionnaire (LSQ) (Honey and Mumford, 1992). A description of the LSQ and the reasons for its employment in this research are given in Sections 3.2.5 and 5.3 respectively. In order to ensure a high response rate, students were asked to complete the LSQ during lecture time. This took an average of between fifteen and twenty minutes. Honey and Mumford (1992) provide a variety of norms in order to aid interpretation of LSQ scores. However, none of these norms proved suitable for use in interpreting the learning style scores of the research population as the populations used in calculating the norms bear little resemblance to the population selected for this research. A norm for the research was calculated using the LSQ scores of 246 students in the research population. This provided a norm based on the responses of the actual population and is therefore more appropriate than the norms provided by Honey and Mumford. Only students with a strong or very strong preference for one learning style were included within the research (Sections 5.3 and 6.5). A copy of the LSQ, the procedure for its scoring and the method used in calculating a norm for its interpretation are described in Appendix B.

## 6.4 Information Retrieval And Individual Characteristics Other Than Learning Style

Previous research suggests that differences within a wide variety of characteristics, other than learning style, may influence information retrieval behaviour. These characteristics are summarised in Figure 6.2 and include gender (Allen, 1991; Fowler and Murray, 1987), topic knowledge (Hsieh-Yee, 1993) and technical aptitude (Borgman, 1989; Balaraman, 1991). Environmental factors such as inadequate space, seating and noise levels may also influence information retrieval (Shneiderman, 1987).

Figure 6.2
Factors Influencing Information Retrieval




It is desirable that differences within the characteristics illustrated in Figure 6.2 do not influence the research outcome. As any influence from these characteristics may obscure the effect of learning style on information retrieval patterns, a homogenous sample was sought. Therefore, a method of minimising differences within each characteristic was employed. For several of the characteristics included in Figure 6.2, variation was minimised through the research design. These characteristics, and their treatment, are described in Section 6.4.1. However, minimising differences within a variety of other characteristics was expected to significantly reduce the number of students available for further participation in the research. For example, eliminating differences in gender by including only males or females. Reducing the target population in this way was undesirable given that the number of students willing to take a further part in the investigation was not known at this stage. Data regarding these characteristics was collected through a pre-test questionnaire and subsequent analysis undertaken in order to assess the extent to which minimising differences within them would affect the final sample size. This analysis, together with the process by which a sample of students was selected, is discussed in Section 6.5. The design of the questionnaire and the characteristics on which data was gathered, are discussed in Section 6.4.2.

### 6.4.1 Minimising The Influence Of Characteristics Other Than Learning Style

The following paragraphs describe the methods employed in minimising the influence of differences in topic knowledge, personality, technical aptitude, academic orientation and environmental factors.

Topic Knowledge

Research by Hsieh-Yee (1993) suggests that topic knowledge may influence information retrieval behaviour. Within the present research, the tasks were designed with the knowledge of the students in mind, ensuring that all students should be able to complete them successfully. The level of topic knowledge required was not low enough to allow students to give answers based on current knowledge. Neither was it so high that students had little idea of which documents were likely to be of relevance or which keywords and phrases would retrieve appropriate information when input into ELINOR's Search facility. Thus, the influence of topic knowledge was not an issue within this research. A description of the tasks is given in Section 6.7.

Personality

Research by Borgman (1989) and Balaraman (1991) (reviewed in Section 4.1) investigates the relationship between information retrieval and, amongst other things, learning style. However, Sections 3.1 and 4.2 indicated that it is not evident whether Borgman and Balaraman view learning style as synonymous with personality, as an element of personality, or as an entirely different concept. Nevertheless, personality is viewed by Borgman and Balaraman as having a potential influence on the way in which people search for information. Research by Van Hoe et al. (1990) found that personality factors such as introversion and neuroticism affect user performance in menu-driven computer interfaces. This also suggests that personality may influence information retrieval.

For the purposes of this research learning style is viewed as one element of an individual's personality (Section 3.1). However, many personality typologies have been developed based on criteria as diverse as social behaviour, pathology, modes of imagery, values, interests, attitudes, and various features of biological constitution (Concise Encyclopedia of Psychology, 1987). Isolating each of these factors to prevent biasing the investigation was not practical given the scope and time limit for this research. For this reason aspects of personality, other than learning style, are not considered within this research. An opportunity for further research lies in ascertaining to what extent other aspects of personality influence information retrieval (Section 9.6).

Technical Aptitude

Research by Borgman (1989) and Balaraman (1991) indicates that technical aptitude may influence information retrieval. However, there is some discrepancy in the notion of technical aptitude adopted by Borgman and Balaraman. Balaraman uses data regarding computer literacy and computer affinity to determine technical aptitude but provides no definition for these terms. Borgman defines technical aptitude as encompassing aptitudes for maths and science in addition to aptitudes for computing, employing formal tests of ability and information on coursework grades in its measurement. Technical aptitude may therefore be viewed as encompassing a variety of factors including computer affinity and computer literacy. For the purposes of this research, computer affinity and computer literacy are considered as indicators of technical aptitude but are treated as separate characteristics. Definitions for both computer affinity and computer literacy are given in Section 6.4.2, together with a description of the method employed in minimising the influence of variation within them.

Academic Orientation

Section 4.1 discussed research by Borgman (1989) which suggested a possible link between academic orientation and information retrieval. The possibility of the research outcome being influenced by differences in academic orientation was minimised as the target population consisted of students from one academic discipline only (Section 6.2).

Environmental Influences

Several factors relating to the task environment may have a potential influence on the investigation. These include inadequate space, seating, lighting and noise (Shneiderman 1987). Students' participation in the research took place in an environment which minimised disturbance. Sufficient seating, lighting, and space were maintained throughout the duration of the research.

### 6.4.2 A Description Of The Pre-Test Questionnaire And Its Role In Preventing Bias From Differences In Characteristics Other Than Learning Style

As discussed in Section 6.4, data regarding several characteristics was collected by a pre-test questionnaire for subsequent analysis in assessing the effect of minimising differences within them on the sample size available. These characteristics were age, gender, ethnic origin, social class, computer affinity, search experience and computer literacy. Students were also asked to indicate whether they were overseas students. "Overseas" refers to those students who have chosen to study in Britain, but are not of British nationality. The questionnaire was entitled "Background Information" for the purposes of the investigation. Use of the word "pre-test" invokes an element of assessment: thus, students may be discouraged from taking a further part, perceiving the exercise to be a test of their ability. The questionnaire was distributed to the target population together with the LSQ.

Effective questionnaire design is essential to ensure collection of the desired data (Hague, 1993; Crimp, 1990; Oppenheim and Naftali, 1992; Denscombe, 1992; Martin-Williams, 1986; Tull and Hawkins, 1993). Therefore, careful consideration was given to the design of the pre-test questionnaire to ensure it was appropriate in gathering the data necessary for the investigation. Advice regarding the questionnaire's structure was gained from a qualified statistician. As the objective of the questionnaire was to ascertain the characteristics of the target population, classification questions (Hague, 1993) were employed. An introduction explains the purpose of the questionnaire, whilst clear instructions indicate how respondents should answer. The terminology used is clear and unambiguous to prevent misunderstanding and questions follow a logical order. The length of the questionnaire was kept to a minimum to maintain interest and a willingness to answer: long questionnaires often discourage people from giving carefully considered answers or from responding at all. The visual appearance of the questionnaire was also considered. It is clear where answers should be placed, and sufficient space is provided for each answer. The questionnaire also thanks students for their time in completing the questionnaire as a matter of courtesy. The characteristics about which information was gathered are described below. A copy of the pre-test questionnaire is included in Appendix C.

Age

Leventhal et al. (1994) investigated the relationship between age and differences in the use of Hypertext. Although no influence from age was found by Leventhal et al., Allen (1991) suggests that age may, nevertheless, influence information retrieval. Allen states that attitudes towards information technology may partly be determined by demographic factors. Many mature students work in industry prior to undertaking their degree course. Therefore it is possible that they have developed skills or knowledge which may influence their information retrieval behaviour.

Within the present research students were categorised into three broad age bands in order to identify mature students. These bands were: 18 - 21; 22 - 25 and; 25 and over. Students falling within the categories 22 - 25 and 25 and over were regarded as mature students.

Gender

Allen (1991) suggests that gender may influence the way in which information technology is used citing research by Krendl et al. (1989), Parasuraman and Igbaria (1990) and Temple and Lips (1989) which found that males were comfortable and confident in using computers, whereas females showed more anxiety. Fowler and Murray (1987) suggest that women are likely to prefer a system-guided approach to information technology. This approach utilises a question and answer type dialogue and restricts the range of user responses to specific sequences. On the other hand, men prefer a more active approach in the form of a flexible dialogue structure which operates through the use of icons. In the present research, data regarding the number of male and female students was gathered in order to assess any influence of gender on information retrieval.

## Ethnic Origin and Overseas Students

Allen (1991) suggests that ethnic origin may influence the way in which people search for information, citing research by Allwood and Wang (1990) in which Swedish scholars placed a higher value on computers than their Chinese counterparts. Still (1996) found differences between the information search strategies of searchers in the United Kingdom, United States, Australia and Canada. Within the present research the majority of students in the target population are of British nationality. However, differences in search behaviour may occur as a result of the multicultural nature of the population. A number of students in the target population are from overseas. Overseas students possess a sufficient level of ability in using the English language to study in this country. It is therefore reasonable to assume they are able to understand the language to an adequate degree for completing the tasks. However, there may be other cultural differences which affect information retrieval behaviour. It was therefore important to gather data regarding the ethnic origin of the students and to identify overseas students.

## Social Class

To the researcher's knowledge no research regarding the influence of social class on information retrieval behaviour has previously been undertaken. However, Sutton (1991) suggests that social class may have an influence on the use of, and attitudes towards, computers. Thus, social class may influence the behaviour of students when using ELINOR. Therefore, it has been included as a variable within this research in order to guard against possible bias.

## Computer Affinity, Computer Literacy and Search Experience

Balaraman (1991) studied the effect of computer literacy and computer affinity on the use of various CD ROM databases for simple and complex tasks. It was found that computer affinity influenced the performance of users undertaking complex tasks within a science database. No influence from computer literacy was found by Balaraman. However, research by Borgman (1989) indicates that technical aptitude is related by transition to information retrieval performance. Within this research computer literacy is considered as an indicator of technical aptitude (Section 6.4.1).

Section 6.2 stated that students undertaking courses within the School of Computing at De Montfort University were chosen for the target population. Students from seven courses were asked to participate in the research. These courses are as follows.

- Computer Science
- Software Engineering
- Management Science
- Combined Studies (Computing)
- Combined Studies (Management Science)
- Business Information Systems
- Computer Systems for Business

The courses were selected for their similar content regarding the topic of prototyping. It was desirable that students should be familiar with this concept in order to complete the "complex" task, described in Section 6.7. The courses were also chosen to minimise variation in computer literacy and/or computer affinity across the target population. However, information regarding these characteristics was collected as a further measure to prevent bias within the research outcome. Computer literacy and computer affinity have been interpreted according to the following definitions. Literacy refers to "*the ability to use language proficiently*" (Collins English Dictionary, 1994). Computer literacy therefore refers to the ability to use computers proficiently. Affinity refers to a natural liking, taste or inclination for a person or thing. (Collins Softback English Dictionary, 1991). Thus a person may have an aptitude for using computers without necessarily liking them or alternatively, a person may enjoy working with computers without having a natural ability to use them.

Computer affinity was determined by coding responses to statements provided in the pre-test questionnaire (Section 8.3). Computer literacy was assessed by asking students to indicate the frequency with which they used the Windows operating environment, mouse and various types of program.

Yuan (1997) found that search experience influences several aspects of information retrieval including the use of operational facilities. Within this research data regarding students' search experience was collected to prevent bias within the research outcome. Search experience was assessed by asking students to indicate the frequency with which a number of information sources were used. These comprised paper sources, the Internet, BIDS, CD ROM, OPAC and microfilm.

A weighting mechanism was used to determine whether students possessed low, moderate or high levels of computer literacy and search experience. This is discussed further in Section 8.3.

## 6.5 Selection Of Sample In Terms Of Nature And Size

The LSQ and pre-test questionnaire were administered to 456 students. Section 6.4 stated that a homogenous sample was sought in order to prevent individual differences in characteristics other than learning style influencing the research outcome. This section details the process undertaken in selecting a suitable sample for the research.

A number of students failed to complete the LSQ. In the majority of cases an incomplete response did not prevent the analysis of learning style preferences. Where analysis was prevented by non-response, students were excluded from taking a further part in the investigation. The learning styles of 15 students could not be determined. This reduced the population to 441.

Section 3.2.5 explained that the LSQ not only identifies an individual's preferred learning style but also the strength of that preference which may be either very strong, strong, moderate, low or very low. The LSQ also identifies instances where respondents have an equal preference for more than one learning style. Section 5.3 stated that only respondents with a strong or very strong preference for one particular learning style were invited to take a further part in the research. This provided the maximum distinction between learning style preferences, allowing the information retrieval patterns and attitudes towards ELINOR's functionality associated with each style to be more easily assessed. Including respondents with lower levels of preference and/or preferences for two or more styles would not provide such a clear distinction.

It cannot be assumed that individuals with moderate, low or very low preferences for a particular learning style will adopt similar information retrieval patterns and attitudes to those with a strong or very strong preference for the same style. Neither can it be assumed that those with an equal preference for more than one learning style will adopt a combination of the patterns and attitudes associated with both styles. For example, if Activists adopt pattern A, and Pragmatists adopt pattern B, it cannot be assumed that those with an equal preference for both the Activist and Pragmatist styles will adopt both A and B. The combination of learning style preferences may result in information retrieval patterns and attitudes which are entirely different from those associated with individual styles. The total number of possible learning style preferences is 75 (see Table 6.1). Analysis regarding the information retrieval patterns and attitudes associated with each of these preferences was not possible to conduct within this research. Table 6.1 illustrates that many of the learning style preferences are held by very few, if any, students. Therefore, insufficient data exists on which to conduct an analysis. Table 6.1 also illustrates that the most predominant learning styles are characterised by a strong or very strong preference for one particular learning style. Therefore, this research is based on the information retrieval patterns and attitudes associated with the learning style preferences held by the majority of students. Investigation of the patterns and attitudes associated with learning style preferences, other than those considered within this research, is identified as an opportunity for further research (Section 9.6).

Table 6.1
The Number Of Students Possessing Each Learning Style Preference (N = 441)

| | Learning Style Preferences | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Strength of Preference | A | R | T | P | AR | AT | AP | RT | RP | TP | ART | ATP | ARP | RTP | ARTP |
| Very Strong | 40 | 37 | 20 | 17 | 1 | 1 | 8 | 15 | 4 | 8 | 1 | 2 | 2 | 8 | 1 |
| Strong | 34 | 22 | 24 | 21 | 5 | 6 | 9 | 4 | 5 | 8 | 0 | 3 | 0 | 3 | 2 |
| Moderate | 10 | 5 | 3 | 0 | 8 | 4 | 9 | 12 | 10 | 5 | 6 | 8 | 11 | 12 | 20 |
| Low | 2 | 1 | 0 | 0 | 2 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Very Low | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

Key: A = Activist R = Reflector T = Theorist P = Pragmatist

226 of the 441 students displayed either a moderate, low or very low preference for one learning style or an equal preference for more than one learning style. The total number of students available for further participation in the research was therefore reduced to 215.

Students were asked to provide their names and addresses to enable contact regarding further participation in the research. However, the LSQ and pre-test questionnaire were separated from this information on return and only a statistical link, through the use of serial numbers, was maintained. All information remained confidential to this research. 6 of the remaining students failed to provide their name. These students were excluded as it was impossible to contact them about further participation. This reduced the total number of students to 209.

Section 6.4 indicated the necessity to minimise influence from other characteristics to ensure, as far as possible that the effect of learning style, alone, was observed. Section 6.4.2 explained that data regarding a number of characteristics was gathered through a pre-test questionnaire in order to assess the effect on the potential sample size of minimising variation within them. With regard to the pre-test questionnaire, some did not read the questions properly and provided inappropriate answers. Others did not take the exercise seriously and in several cases it was extremely questionable whether their answers were truthful. 52 of the remaining students failed to complete the pre-test questionnaire in the required manner. These students were also excluded, leaving 157 in total. Subsequent analysis of the questionnaire results indicated that mature students and overseas students accounted for 30 of those not already excluded. As this was a relatively small proportion (19%) only students aged between 18 and 21 years of age and of British nationality were selected for further participation in the research. Thus, consistency was maintained with regard to these characteristics. This reduced the number of students to 127.

Analysis of the pre-test questionnaire revealed that minimising differences in gender, ethnic origin, social class, computer affinity, computer literacy and search experience would have a greater influence on the potential sample size. Therefore, differences within these characteristics were allowed to remain until the number of students willing to take a further part in the investigation was known.

Students were contacted by letter or email (where appropriate) regarding further participation in the research. A timetable was provided in the library for students to select a suitable appointment. However, this proved ineffective in persuading students to take part. Therefore, where possible, students were contacted by telephone to arrange an appointment and letters confirming the appointments sent a few days in advance to remind students to attend. This method proved more effective in persuading students to take part. Lecturers were also approached to arrange a convenient time when the students could be contacted in lecture time. This proved useful in reaching those who had previously failed to return phone calls, did not have a phone, or had failed to keep previous appointments. Slips were provided for all those making appointments during lecture time, giving the time, place and contact details in case they could not keep the appointment and wished to rearrange. Letters were again sent out a few days prior to the appointment. Contacting students during lecture time proved to be the most successful method in persuading students to participate. A small incentive was also given to reward students for their time. This comprised photocopy cards to the value of three pounds for use in the library at De Montfort University.

53 students took a further part in the research. These comprised 19 Activists, 16 Reflectors, 12 Theorists and 6 Pragmatists. Analysis of data regarding differences in gender, ethnic origin, social class, computer affinity, computer literacy and search experience revealed that variation within these factors could not be minimised without reducing the sample size further. As the Theorist and Pragmatist learning style groups comprised few members, this was undesirable. Subsequent statistical analysis was undertaken to assess the effect of any influence from these variables on the research outcome, the results of which are discussed in Section 8.3. Table 6.2 summarises the process undertaken in gaining a suitable sample.

Table 6.2
A Summary Of The Process Undertaken In Gaining A Suitable Sample

| Total Population Size | | | | 456 |
|---|---|---|---|---|
| | No. Of Students Eliminated | Reason for Elimination | No. Of Students Remaining | |
| | 15 | Non-response to LSQ | 441 | |
| | 226 | Learning style preferences other than a strong or very strong preference for one learning style | 215 | |
| | 6 | Failed to provide a name | 209 | |
| | 52 | Inadequate response to pre-test questionnaire | 157 | |
| | 30 | Overseas and/or mature students | 127 | |
| | 74 | Non-Participation | 53 | |
| Final Sample Size | | | | 53 |

A larger sample may allow greater accuracy in determining the influence of learning style on patterns of information retrieval and user requirements regarding ELINOR's functionality. However, the time constraint within this research did not permit such a sample to be gained. Each of the 53 students who participated in the research took, on average, one and a half hours to complete the training and tasks. The training programme and tasks are described in Sections 6.6 and 6.7, respectively. Furthermore, for each student, between two and three hours was required in transcribing the data from the logging system. The logging system is described in Section 6.8.1. Recruitment of students for participation in the research also proved problematic. Factors such as coursework requirements, revision for exams, and employment commitments outside the University all posed constraints on the students' time. Therefore, a number of students felt unable to take part. Others did not honour their agreement to participate. Offering a larger incentive may have encouraged more students to participate. However, the resources for doing so were not available. Nevertheless, the sample size of 53 is comparable with those of similar studies (described in Section 4.1), in which sample sizes of between 30 and 76 students were used.

Greater equality in the distribution of students within the learning style groups may also allow greater accuracy in determining information retrieval patterns and user requirements. However, little control could be gained over the nature of the sample. The sample was, in part, determined by measures taken to minimise the influence of differences within characteristics other than learning style. The sample was also self selecting, participation being dependent on the willingness of students to do so.

The distribution of the 53 students within the learning style groups may result from an interaction between learning style and willingness to participate. For example, the high proportion of Activists may reflect the propensity for this group to be involved in new experiences and situations. However, a similar distribution of learning styles was found within the total population of students which revealed 73 Activists, 58 Reflectors, 43 Theorists and 38 Pragmatists. The distribution of learning styles is also comparable to that observed in research by Clibbon (1995). Clibbon employed the LSQ in identifying the learning styles of 85 students. Analysis revealed 32 Activists, 31 Reflectors, 11 Theorists and 11 Pragmatists. Therefore, the learning style distributions may reflect the nature of the student population, in which few Theorists and Pragmatists may exist. For this reason, the recruitment of large groups which are equal in their learning style distributions may be difficult to achieve.

Each of the students in the final sample undertook training and tasks using ELINOR, completed an evaluation questionnaire and were interviewed. These activities are described in Sections 6.6 to 6.8, inclusive.

## 6.6 Training

A training programme was designed for all students to complete prior to the tasks. The objective of the training was to ensure each student held similar levels of experience in using ELINOR and was familiar with the functionality necessary for performing the tasks. An explanation of ELINOR's entire range of operations was inappropriate. This would have been a lengthy process, possibly requiring more than one training session for sufficient knowledge to be gained. Conducting more than one training session was undesirable. Students were requested not to miss lectures in order to participate. Thus, a considerable amount of time may elapse between sessions, causing students difficulty in retaining the information previously learnt. It would also require students to concede more of their time, discouraging them from participating. However, the programme explained that additional operations were available if students wished to use them. ELINOR provides alternative methods for performing several of the operations included in the training programme (Section 2.3). As data regarding the patterns of information retrieval associated with learning styles was required, it was necessary to explain each method to allow students choice in their approach to the tasks. In order to make learning effective, the learning event should be sufficiently in line with an individual's preferred learning style (Williams, 1987). Completion of the training programme was undertaken on an individual basis. It may be argued that this approach does not suit every learning style. However, as the training programme is relatively short, any influence on learning was expected to be minimal.

An initial version of the training programme was developed and tested with volunteers. The volunteers comprised librarians and a student undertaking the placement year of the BSc Software Engineering course at De Montfort University. The training programme provided volunteers with choices regarding the order of completion. Telling students how to search in a particular way would bias any results regarding the effect of learning style on information retrieval behaviour. Volunteers were guided through each stage by the author. A standardised script ensured the information provided was consistent for each volunteer. Completion time, for this version of the training programme was, on average, 1 hour. Volunteers were asked for their comments regarding the training programme's design. The volunteers suggested that an example similar to one of the tasks be used throughout the programme to show the various methods of searching provided by ELINOR. Time to practice using each operational facility was also thought to be important. Some found the provision of alternative methods for performing operations confusing. Choice regarding order of completion also made the programme seem illogical and hard to understand. A guide for volunteers to work through on their own (with help provided if needed) and notes to refer to during the tasks was also suggested.

The above comments were considered in designing a second version of the training programme for further trial with volunteers which, again, consisted of librarians. The programme was redesigned as a constrained walkthrough for volunteers to complete on their own. It was also intended for use as a reference guide during the tasks. Volunteers were allowed to complete the programme in their own time giving greater opportunity for practice. The use of examples similar to the actual tasks was not possible as examples of all three tasks would have to be included in order to prevent bias, making the programme too lengthy. Choice regarding order of completion was eliminated. Inclusion of several methods for performing operations could not be excluded as choice was necessary to assess the patterns of information retrieval associated with each learning style group. Trial of the second version proved the training programme to be acceptable. General comments highlighted the need for only minor amendments. Completion time was, on average, 30 minutes. Help from the researcher was not needed at any stage within the programme. A copy of both versions of the training programme are included in Appendix D.

### 6.7 Tasks

Three tasks were provided to assess the influence of learning style on information retrieval and; ELINOR's ability to support information retrieval over a range of tasks. Maintaining students' enthusiasm and interest was desirable as the investigation required each student to spend between one and two hours using ELINOR. Therefore, the tasks were based as closely as possible on the content of the courses being undertaken by the students. It was hoped this would provide students with interest and an opportunity for gaining knowledge beneficial to their studies. The tasks were as follows.

Task 1
Name the authors of the document called "Expert Systems: Tools and Applications"

Task 2
Find the 1993 BIS Year 2 Social Aspects of Computing exam paper.
What is its first question ?

Task 3
You have been asked to write a report explaining the concept of prototyping in information systems. Using ELINOR to find the information, produce a list of references which refer to the passages you would use in writing the report. The references must include:

Title of Document
Author(s)
Year (where appropriate)
Volume and Issue (where appropriate)
Page Number

Tasks 1 and 2 are described as "simple" tasks requiring students to find specific items contained within ELINOR. Task 3 is described as "complex", requiring students to browse through the content of documents to find information on the subject of prototyping. It was expected that the simple tasks would be completed relatively quickly. Therefore, including two simple tasks gave greater opportunity to observe the information retrieval patterns and user requirements for this type of task. The completion of Task 3 was expected to take longer. Tasks 1 and 2 reflect the types of activity in which students may engage when using ELINOR to supplement the information gained from other sources (Task 1) or for revision purposes (Task 2). By contrast, Task 3 reflects the use of ELINOR as a single source of information in completing an essay or report.

## 6.8 Data Collection

Data was collected by use of a logging system, evaluation questionnaire and interviews. The logging system provided data regarding the number and nature of documents and operational facilities used by each student in each task. The evaluation questionnaire and interviews provided information regarding the extent to which ELINOR supports students' information retrieval activities. The logging system, evaluation questionnaire and interviews are described in Sections 6.8.1, 6.8.2 and 6.8.3, respectively. The logging system also provided data regarding the length of time students spent between actions and the total time spent undertaking each task. The sequence in which actions were performed was also recorded together with the number of times each document or operational facility was used. Although this data is not required for the present investigation, it may be of interest in further research regarding the relationship between learning style and patterns of information retrieval. The use of serial numbers maintained a statistical link between the data gained from the logging system, evaluation questionnaire, interviews, and responses to the LSQ and pre-test questionnaire. There was no other link to individuals, thus the anonymity of the students was preserved.

### 6.8.1 Logging System

It was important to track the progress of students through the tasks in order to ascertain the patterns of information retrieval regarding the use of operational facilities and documents. As methods such as protocol analysis (which requires users to "think aloud" whilst completing tasks) and observation by the investigator may distract or intimidate students, Transaction Log Analysis (TLA) was employed. TLA may be defined as:

> *"the study of electronically recorded interactions between on-line information retrieval systems and the persons who search for the information found in those systems"* (Peters et al., 1993, p. 38).

Such a method allows unobtrusive observation overcoming the difficulties associated with other methods of logging data. Students were unaware that their actions were being recorded. Knowledge of this fact may have created a feeling of self-consciousness, causing students to proceed cautiously with concern for "doing something wrong". Although it may be argued that this approach is not entirely ethical, in this instance a true representation of information retrieval patterns may not have been gained had students been aware of the logging system.

The investigation was therefore conducted with sufficient ethicality to the point at which bias may have influenced the data. The logging system and the method employed in extracting the relevant data for the investigation are described in Appendix E.

### 6.8.2 Evaluation Questionnaire

Transaction logs are incapable of recording users' perceptions of their searches or reflecting users' satisfaction (Kurth, 1993; Robertson and Hancock-Beaulieu, 1992). Therefore, students were asked to complete an evaluation questionnaire. The questionnaire asked students about their attitudes towards the number and nature of documents and operational facilities contained within ELINOR. This allowed an assessment of ELINOR's ability to support the information retrieval activities associated with different learning styles. The benefits of using questionnaires or interviews to enhance the information collected by transaction logs is recognised by Robertson and Hancock-Beaulieu (1992). The evaluation questionnaire was subjected to similar design considerations as the pre-test questionnaire (described in Section 6.4.2). Three versions of the questionnaire were produced as a result of the students misinterpreting one of the questions. This issue is discussed in Section 7.2.2. A description of each version of the questionnaire, copies of which are included in Appendix F, is also included in Section 7.2.2.

### 6.8.3 Interviews

Interviews were undertaken with each of the 53 students in the research sample following completion of the training programme, tasks and evaluation questionnaire. The purpose of the interviews was to provide further validation of the research methodology by gaining an insight into the attitudes of students towards each stage in the research experience. For example, students were asked whether the training was sufficient for the tasks; whether they understood what was required in completing the tasks and; whether the evaluation questionnaire was easy to complete. The responses provided further evidence that the research methodology is appropriate for the investigation. The interviews also indicated whether students felt able to complete the tasks in the way they wanted. Thus, the interviews supplied additional information about ELINOR's ability to support information retrieval, supplementing the data provided by the evaluation questionnaires. This was particularly beneficial in gaining clarification of responses to Question 3, after it was realised that a number of students were not responding in the required manner (Section 7.2.2).

The interviews were conducted in an informal manner. However, consistency was maintained in the nature and order of questions to prevent bias. Completion of the training programme, tasks and evaluation questionnaire took between one and two hours. Therefore, the time taken to conduct the interviews was kept to a minimum, lasting approximately 10 minutes. The exercise was used to gain a general, rather than detailed, indication of students' attitudes. Therefore, open-ended questions were used, allowing students to express their opinions without leading them towards any particular issue or response. Each interview was transcribed to produce a formal record of the students' responses. A full description of the interview structure and the procedure adopted in conducting the interviews is provided in Appendix G, together with a summary of the responses obtained.

## 6.9 Pilot Study

Care was taken in the design of the training programme, tasks, evaluation questionnaire and interviews to ensure they were appropriate for the investigation. However, a pilot study was undertaken to further ensure their suitability. The pilot study was conducted with the first 5 students who agreed to take part in the research. No problems were found with any aspect. Therefore, the data collected for the 5 students was included within the final analysis.

**Summary**

This chapter described the methodology employed within this research. Briefly, the stages within the methodology comprise: identification of a target population and the learning styles of individuals within it; gathering of data regarding a variety of other characteristics to assess their influence on the research outcome; the selection of a sample of students to undertake training and tasks using ELINOR; recording of the number and nature of documents and operational facilities used in each task and; recording of students' attitudes regarding the ability of ELINOR to support their preferred approach to information retrieval.

The methodology is considered highly appropriate for the investigation, allowing sufficient data to be gathered for answering the research questions (stated in Section 5.1). The research gathers quantitative data regarding patterns of information retrieval, learning styles, demographic characteristics and attitudes towards ELINOR. However, interviews were also employed in gaining more qualitative data. This data was used in assessing the suitability of the research methodology and aiding interpretation of the evaluation questionnaire. These methods are in accordance with the recommendations of Galliers and Land (1987) regarding appropriate methods for information systems research.

Chapter 7 details a number of decisions concerning the treatment of the data gathered from the logging system and evaluation questionnaire. The decisions were necessary in order to prevent bias and ensure the data accurately represents the patterns of information retrieval and attitudes held towards ELINOR.

# CHAPTER 7

## MAJOR DECISIONS REGARDING THE DATA ANALYSIS

Section 5.4 stated that the research focuses on the process or patterns of information retrieval associated with user groups with differing learning styles when performing a range of tasks (described in Section 6.7). Patterns were observed according to use of ELINOR's functionality in terms of the document content and operational facilities. A logging system (described in Section 6.8.1) was employed to track the progress of each student through each task and gather data regarding patterns of information retrieval. The research also focuses on the ability of ELINOR to support the information retrieval activities of each learning style group. Attitudes towards the extent to which students felt constrained by ELINOR's functionality when performing the tasks were collected through use of a questionnaire (Section 6.8.2) and interviews (Section 6.8.3).

Before analysis of the information retrieval patterns and attitudes associated with different learning style groups could be undertaken a number of decisions were required. These decisions concerned the treatment of the initial data gathered from the logging system and evaluation questionnaire. The decisions were necessary to ensure the data accurately represents the patterns of information retrieval and attitudes held towards ELINOR. Sections 7.1 and 7.2 detail these decisions.

### 7.1 Decisions Regarding Data From The Logging System

A transcription of the data from the logging system was undertaken in order to create a more formal record of each document and operational facility used by each student in the tasks. This required each recorded session to be viewed and notes made regarding the details of documents and operational facilities used. A detailed description of the methods employed in transcribing the data are given in Appendix E. It became apparent from both the initial transcription of the data and the author's experience of ELINOR that care was required in the treatment of the data to ensure the information retrieval patterns of students are accurately represented. Decisions regarding the treatment of the data are described in Sections 7.1.1 to 7.1.3, inclusive.

### 7.1.1 The Context In Which Documents And Operational Facilities Are Considered As Being "Used"

In order to accurately record the number and nature of documents and operational facilities used in each task, decisions regarding the context in which the term "use" should be applied were necessary. The following paragraphs detail the nature of these decisions.

Where selection of an operational facility leads to, for example, a dialog box, the operational facility is considered as having been used even if no subsequent use is made of the dialog box. This decision has been based on the possibility that the student may be exploring the system by trying different operational facilities to see what functions they perform. For complex tasks Theorists and Reflectors are expected to explore ELINOR's functionality more than other learning style groups, using a greater number of documents and operational facilities (Section 8.1). Therefore, excluding actions which are associated with the exploration of facilities may not provide an accurate representation of the information retrieval behaviour associated with these groups.

A student may browse a menu without selecting any operational facilities within it. Where this occurs students are considered as merely assessing the nature of the facilities provided by ELINOR rather than using them. This activity can be differentiated from exploring ELINOR in which a conscious decision is taken by the student in selecting a facility, even if it later proves unsuitable for their needs and no further use is made.

ELINOR operates within a Windows environment. Several operational facilities are common to more than one of ELINOR's windows. For example, the "Dismiss" facility appears within all windows except the Control Window. Facilities which are alike, but are available in different windows, are considered to be different from one another. For example, the Dismiss button in the Fileroom Window and the Dismiss button in the Search Window are considered to be different from one another, even though they fulfil the same purpose.

The term "Windows operational facilities" may be used to define those facilities common to any application utilising Microsoft Windows™ software. Data regarding the use of Windows operational facilities was excluded from the analysis of information retrieval patterns. This decision was taken to prevent possible bias from differences in students' knowledge and experience of Windows prior to the research. All the operational facilities specific to ELINOR have been included within the analysis. None of the students were expected to have used ELINOR prior to the research (Section 6.2). Training ensured that all students held similar levels of knowledge and experience in the use of ELINOR (Section 6.6).

The "Launch Text" and "Launch Image" operational facilities allow ELINOR's text and image pages to be loaded into either a text editor (for example, Microsoft Notepad™) or image editor (for example, JASC's Paintshop Pro™) for annotation purposes. Use of the "Launch Text" and "Launch Image" facilities has been recorded within the number and nature of operational facilities employed. However, the text and image editors associated with these facilities are not considered integral to ELINOR. As students may have differing levels of experience in the use of these applications, their inclusion within the total number of facilities used may introduce bias within the data. Therefore, any subsequent use of these applications has been excluded from the analysis of information retrieval patterns.

ELINOR provides a Help facility to support the use of other operational facilities within ELINOR. Use of the Help facility has also been excluded from the number of operational facilities used. Although this facility may be regarded as part of ELINOR, its purpose is to provide support and, as such, is not immediately related to the task.

The full-text of the documents contained within ELINOR may be viewed through the Text and Image Windows (described in Section 2.3.5). The other windows provide information about the documents but do not contain the full-text. Providing the full-text of documents is the main objective of ELINOR, thus the Text and Image Windows provide the means by which this objective is fulfilled. Documents have only been considered as used if one or more text and/or image pages within a particular document were accessed.

Task 1 asks students to name the authors of the document called "Expert Systems: Tools and Applications" (Section 6.7). Students may find the correct answer to Task 1 without accessing any text or image pages. It is possible to find this information through facilities providing bibliographic details, for example, the Document Control facility (Section 2.3.4). Thus, the number of documents viewed for Task 1 may be zero.

### 7.1.2 Start And End Of Tasks

In order to accurately record the number and nature of documents and operational facilities used in each task, it is necessary to establish the point at which students complete one task and begin another. The training programme describes the Control Window as the starting point within ELINOR. However, as each window may be accessed from any other window (Section 2.3) it is not necessary to return to the Control Window before starting a subsequent task. Indeed, data from the logging system illustrated that some students did not return to the Control Window. Thus, it was not always distinct where students had completed one task and started another. Some students even worked on tasks simultaneously. The task on which students were working at any one time was ascertained from the clue words entered (if using the Search Window) or the types of document browsed (if using the Fileroom Window). Observation of the operational facilities used prior to browsing documents and/or entering a clue word allowed a logical progression (either forwards or backwards) through each window to be established and the exact point at which tasks started and ended to be ascertained.

### 7.1.3 Software Problems

In some instances, ELINOR's interface shows that actions have been performed but no operational facilities appear to have been selected by the student. In other instances, ELINOR does not respond to an action causing the student to try an alternative method for performing the same operation, where this is possible (Section 2.3). These effects have been attributed to software defects or "bugs". ELINOR uses software supplied by Excalibur Technologies (Section 2.3). It is therefore assumed that quality testing has taken place. However, it is likely that some defects may remain. As Dunn and Ullman (1994) state:

> *"no degree of quality control can assure that a computer program, save for the most trivial, can ever be placed into use totally free of "bugs"* (p. 88).

It must be ensured that the research outcome is not influenced by inaccurately recording the number and nature of operational facilities. The extent to which the outcome was influenced by system defects is considered in Section 8.1.2.

## 7.2 Decisions Regarding Data From The Evaluation Questionnaire

Although measures were taken to ensure an appropriate questionnaire design, the data gathered from the evaluation questionnaire (Section 6.8.2) revealed a number of unexpected responses. This made assessment of the extent to which students felt constrained by ELINOR's functionality difficult. Therefore, a number of decisions regarding the treatment of responses were necessary before further analysis could be undertaken. Before the nature of these decisions is explained, it is necessary to provide greater detail regarding the evaluation questionnaire. Each question, together with its purpose in gathering the data required, is described in Section 7.2.1. The decisions are described in Section 7.2.2.

### 7.2.1 The Evaluation Questionnaire: Description And Purpose

The purpose of Question 1 (shown in Figure 7.1) was to gain an overview of the attitudes held by students regarding ELINOR. A number of scales were devised with the learning styles identified by the LSQ in mind. These scales describe qualities important to one or more learning styles. For example, Activists enjoy new experiences and may like using ELINOR if they find it innovative; Pragmatists may dislike ELINOR if they feel it is of little practical use. Students were asked to consider each scale and indicate, by circling a number, their opinion of ELINOR. For example, if the student thought ELINOR to be particularly challenging, they would circle the number "1" on the scale described by the words challenging/uninspiring. This question also provided the opportunity to gain an overview of the extent to which students were constrained by ELINOR from responses to the scale labelled "constraining/unconstraining". The responses to Question 1 are discussed in Section 8.2.

Figure 7.1
Question 1

Describe ELINOR on the scales below by circling the number that most closely corresponds to the system.

| | | | | | | |
|---|---|---|---|---|---|---|
| Challenging | 1 | 2 | 3 | 4 | 5 | Uninspiring |
| Innovative | 1 | 2 | 3 | 4 | 5 | Ordinary |
| Constraining | 1 | 2 | 3 | 4 | 5 | Unconstraining |
| Useful | 1 | 2 | 3 | 4 | 5 | Little practical use |
| Interesting | 1 | 2 | 3 | 4 | 5 | Boring |
| Methodical | 1 | 2 | 3 | 4 | 5 | Unstructured |

It was explained in Section 5.1 that the research examines whether ELINOR can support the information retrieval activities associated with different learning styles. Question 2a was designed to ascertain whether students were able to complete the tasks to their satisfaction. Question 2b asks students whether they felt comfortable with the way in which ELINOR allowed information to be retrieved. Questions 2a and 2b are depicted in Figure 7.2.

Figure 7.2
Questions 2a and 2b

Please indicate how much you agree or disagree with the following statements by placing a tick in the appropriate boxes.

a) I was able to complete the tasks to my satisfaction.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

b) I felt comfortable with the way in which ELINOR allowed me to approach the tasks.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

Questions 3 and 4 (shown in Figures 7.3 and 7.4, respectively) were designed to gain an insight into whether students' information retrieval activities were constrained by ELINOR's document content and operational facilities. Question 3 asks students to indicate their preferences regarding the number of documents provided by ELINOR and, where applicable, to which document types their answer relates. A showcard listing the document types contained within ELINOR was provided to help students respond. The showcard is included in Appendix F. Question 4 asks students to indicate their preferences regarding the number of operational facilities provided and, where applicable, which facilities should be included or excluded.

Figure 7.3
Question 3

a) **In order to complete each task** would you have preferred the number of documents provided by ELINOR to be: (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, which documents should ELINOR provide more of? (Please refer to the list provided)

Task 1 ..........................................................................................................................
Task 2 ..........................................................................................................................
Task 3 ..........................................................................................................................

c) If fewer, which documents should ELINOR provide less of? (Please refer to the list provided)

Task 1 ..........................................................................................................................
Task 2 ..........................................................................................................................
Task 3 ..........................................................................................................................

Figure 7.4
Question 4

a) In performing the tasks would you have preferred the number of operational facilities provided by ELINOR to be: (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, describe any additional operational facilities which you feel ELINOR should provide.

Task 1 ......................................................................................................................
Task 2 ......................................................................................................................
Task 3 ......................................................................................................................

c) If fewer, describe any operational facilities which you feel should be excluded or were not useful.

Task 1 ......................................................................................................................
Task 2 ......................................................................................................................
Task 3 ......................................................................................................................

Question 5 (shown in Figure 7.5) was designed to identify any constraining factors other than ELINOR's document content or operational facilities.

Figure 7.5
Question 5

a) Were there any other aspects of ELINOR which constrained your approach to the tasks? (Please indicate to which task(s) your comment(s) refer).

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

b) Have you any suggestions for improving these aspects?

..........................................................................................................................................

..........................................................................................................................................

..........................................................................................................................................

It was expected that an indication of the extent to which students were constrained would be revealed by responses to Questions 2a and 2b. The reasons for any constraint would then be apparent from Questions 3, 4 and 5. However, inconsistencies in the students' responses caused difficulty in assessing whether they were constrained or otherwise. Therefore, a number of decisions were required in order to categorise students. These decisions are detailed in Section 7.2.2.

### 7.2.2 Decisions Regarding The Categorisation Of Students As Constrained Or Unconstrained

A number of students gave responses to Question 5 and/or the interviews which clearly indicated that constraint was caused by ELINOR's operational facilities despite their response to Question 4 which indicated otherwise. Where this occurred, students have been considered constrained by operational facilities regardless of their answer to Question 4. Where students indicated in Question 5 and/or the interviews that constraint was caused by ELINOR's document content, they have been considered constrained by the document content regardless of their response to Question 3. Therefore, Questions 3, 4, 5 and the interviews have been used in conjunction with one another to ensure that all instances of constraint by ELINOR's operational facilities and document content have been recorded.

A number of students preferred ELINOR's document content and/or operational facilities to be altered despite indicating in Question 2 that they were able to complete the tasks to their satisfaction and were comfortable with the methods by which ELINOR allowed the tasks to be performed. Even though ELINOR's present functionality appears sufficient in supporting the information retrieval activities of these students, it is clear that they require something more of the system. Therefore, these students have been considered as constrained.

When responding to Questions 3 and 4, several students indicated a preference for the same amount of documents and/or operational facilities but also completed parts b and/or c, i.e. those sections providing opportunity to indicate in what way ELINOR's document content and/or operational facilities should be altered (Figures 7.3 and 7.4). In these instances, the student's response to parts b and/or c have been considered as their true answer.

In completing Question 5 students were asked to indicate to which task or tasks their comments referred. However, a number of students did not do this. It has already been explained that some of the responses to Question 5 clearly related to documents and/or operational facilities. Where this occurred, and constraint had already been established in all three tasks from responses to Questions 3, 4 and the interviews, the task to which the response to Question 5 refers was irrelevant. Where constraint had not already been established for a task the data has been excluded from the analysis.

In responding to Questions 3, 4 and 5, some students stated the nature of their difficulty rather than its cause. In such cases, the actual reason for constraint cannot be assumed. Nor can it be assumed that students would want extra documents and/or operational facilities in order to overcome this constraint. These students have been considered unconstrained by ELINOR's document content and/or operational facilities for the particular task or tasks in question unless constraint has been established elsewhere in the questionnaire.

Several students stated a preference for a different number of operational facilities. However, when asked by Question 4 to state the nature of the facility to which their response referred, the answers clearly related to factors other than operational facilities. For example, training for a range of tasks other than those included within this research. Where this occurs, students have been regarded as unconstrained by operational facilities for the task in question. Where the response to Question 4 relates to document content, students have been considered as constrained by ELINOR's document content for the task in question regardless of their response to Question 3.

Some students indicated a preference for operations to be performed "automatically" by ELINOR rather than the user being required to select a menu or button. An operation which is performed automatically does not fall within the description of an operational facility adopted for this research. This definition was given in Section 5.1 as:

> *"any aspect of ELINOR's interface which allows the user to initiate an action, process or operation, usually by selection of an icon or menu."*

Where constraint results from the requirement for automatic operations, the student has not been considered constrained by operational facilities.

Some students indicated a requirement for operational facilities which already exist within ELINOR. It has been assumed that these students did not explore ELINOR in enough depth to find these facilities and do not realise they exist. Therefore, the students have been categorised as constrained.

Several students indicated a preference for a greater number of documents in order to complete Tasks 1 and 2. This response is surprising given that the tasks required students to find specific documents. Several students also indicated that, in order to complete Tasks 1 and 2, they preferred more documents of a different type from those required by Tasks 1 and 2. These responses appear to be irrational. The questionnaire was carefully designed, approved by a qualified statistician and tested to ensure, amongst other things, that the instructions for completion were clear and free from ambiguity (Section 6.8.2). However, it seems the students had misunderstood what they were being asked to do. This was confirmed by the interviews which revealed that in completing Question 3, a number of students omitted to relate their answers to the task, and responses reflected more general attitudes towards ELINOR's document content (see Appendix G). In total, three versions of the evaluation questionnaire were used in the research. Each subsequent questionnaire provided greater emphasis and clarity as to the requirements for completing Question 3 and an improved method of response. The questionnaires are included in Appendix F. Each version of Question 3 is described below, together with an explanation of how its design was developed in order to encourage a correct method of response.

The first version of Question 3 (shown in Figure 7.6) provided a list of document types. The question asked students to indicate whether they preferred more, the same number, or fewer documents of each type by selecting the appropriate letter: M, S or F. As Tasks 1 and 2 required specific documents to be found, some of the document types were irrelevant to these tasks. Therefore a fourth letter, D, was also provided for students to indicate if they felt the document type to be irrelevant or did not know the answer. Students were required to repeat the exercise for each of the three tasks. This requirement was highlighted in bold text and included in the instructions for answering the question.

Figure 7.6
Design Of Question 3: Version 1

**For each task in turn**, please indicate if ELINOR should contain more documents (ring **M**), the same number of documents (ring **S**) or fewer documents (ring **F**). If you do not know the answer or feel that it is irrelevant to the task, ring **D** (for don't know).

| | Task 1 | | | | Task 2 | | | | Task 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Books | M | S | F | D | M | S | F | D | M | S | F | D |
| Course Materials : | | | | | | | | | | | | |
| Exam papers | M | S | F | D | M | S | F | D | M | S | F | D |
| Handbooks | M | S | F | D | M | S | F | D | M | S | F | D |
| Lecture Notes | M | S | F | D | M | S | F | D | M | S | F | D |
| Study Guides | M | S | F | D | M | S | F | D | M | S | F | D |
| Syllabi | M | S | F | D | M | S | F | D | M | S | F | D |
| Journals | M | S | F | D | M | S | F | D | M | S | F | D |
| Library In-house Collection | M | S | F | D | M | S | F | D | M | S | F | D |
| Staff Publications | M | S | F | D | M | S | F | D | M | S | F | D |
| Student Projects | M | S | F | D | M | S | F | D | M | S | F | D |

From the responses given, it was thought some students may not have considered that certain document types were irrelevant to Tasks 1 and 2. Therefore, a second version of Question 3 was developed which placed greater emphasis on this aspect in the hope that students would consider their responses more carefully. The format for the revised Question 3 differed from that depicted in Figure 7.6 in that the category labelled D was replaced with an I, for "irrelevant". A bold typeface was used within the instructions for response to bring to the attention of students the fact that some document types may be irrelevant. The revised instructions are shown below:

> "**For each task in turn**, please indicate if the number of documents within ELINOR should change. If you think there should be more documents, ring **M**. If you think there should be the same number of documents, ring **S**. If you think there should be fewer documents, ring **F**. **You may feel that some types of document are irrelevant to the task. In this case, ring I.**"

Despite these modifications, a number of students continued to misinterpret Question 3. Therefore, a third version of Question 3 was developed. This is shown in Figure 7.7.

Figure 7.7
Design Of Question 3: Version 3

a) **In order to complete each task** would you have preferred the number of documents provided by ELINOR to be: (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, which documents should ELINOR provide more of? (Please refer to the list provided)

Task 1 ..........................................................................................................

Task 2 ..........................................................................................................

Task 3 ..........................................................................................................

c) If fewer, which documents should ELINOR provide less of? (Please refer to the list provided)

Task 1 ..........................................................................................................

Task 2 ..........................................................................................................

Task 3 ..........................................................................................................

The third version of Question 3 employed a format which was similar to that of Question 4 (see Figure 7.4), which asks students about similar issues in relation to operational facilities, and to which students responded correctly. A show card was provided (included in Appendix F) listing the document types previously provided by the first two versions of Question 3. The author also gave verbal explanation of the requirements for responding at the time of completion, stressing the need to relate each answer to the task in question. Even so, a number of students still failed to answer Question 3 as required. Although students misinterpreted Question 3, they have been regarded as constrained if they indicated a preference for either greater or fewer documents. Students have been regarded as unconstrained if they indicated a preference for the same number of documents, unless the responses to other questions or the interviews indicated otherwise. Students have also been regarded as unconstrained if they indicated that all document types were irrelevant for the task in question or indicated that they did not know the answer.

**Summary**

This chapter detailed a number of decisions which have been taken regarding the treatment of the initial data from the logging system and evaluation questionnaire. The decisions were required in order to prevent bias and ensure the data accurately represents the patterns of information retrieval and attitudes held towards ELINOR. Problems encountered regarding students' responses to the evaluation questionnaire led to a number of changes in the design of Question 3. These were discussed in Section 7.2.2.

Chapter 8 describes the methods undertaken in analysing the data gained from the investigation. Results regarding the relationship between information retrieval and learning style, and the extent to which ELINOR can support the information retrieval activities of different learning style groups, are presented.

# CHAPTER 8

## DATA ANALYSIS

This chapter describes the methods employed in analysing the data from the research and the research outcome. Hypotheses were developed regarding the patterns of information retrieval likely to be adopted by different learning style groups and; the ability of ELINOR to support the information retrieval activities of those groups. The hypotheses were investigated by examining relevant summaries of data and confidence intervals. Analysis of the patterns of information retrieval associated with different learning style groups is described in Section 8.1. Specifically, Sections 8.1.1 and 8.1.2 examine these patterns in terms of the number and nature of documents, and operational facilities used. Section 8.1.3 examines use of the Search and Fileroom facilities. The ability of ELINOR to support information retrieval by each learning style group is analysed in Section 8.2. Section 8.3 analyses the information retrieval patterns associated with characteristics other than learning style. The ability of ELINOR to support the information retrieval activities associated with these characteristics is also analysed.

### 8.1 Analysis Of Patterns Of Information Retrieval

A major objective of the research is to investigate the influence of learning style on patterns of information retrieval from ELINOR over a range of tasks. Data from the logging system (Section 6.8.1) was used to assess whether any differences exist in the patterns of information retrieval adopted by Activists, Reflectors, Theorists and Pragmatists. "Patterns" were observed in terms of the number and nature of both documents and operational facilities used for each of three tasks. As stated in Section 5.4, the term "nature" refers to the range or number of different types of document and operational facility. Tasks 1 and 2 were described as "simple" tasks (Section 6.7), requiring students to answer questions using specified documents. Task 3 was more complex requiring students to browse through the content of documents and find information on a broad topic area.

A sample of 53 students took part in the research, comprising 19 Activists, 16 Reflectors, 12 Theorists and 6 Pragmatists. Section 6.5 explained that a larger sample, with a more equal distribution of learning styles, may provide greater indication of differences in the patterns of information retrieval adopted by learning style groups. However, such a sample could not be gained because of constraints associated with time, resources and the willingness of students to participate. The distribution of learning styles within the sample is similar to that observed within the total population. It is also similar to that observed in previous research (Clibbon, 1995). Therefore, few Theorists and Pragmatists may exist within the student population as a whole, making the recruitment of large groups of equal distribution in learning styles difficult to achieve.

If differences in the patterns of information retrieval among learning style groups become apparent, then learning style may require consideration when designing ELS such as ELINOR. However, the magnitude of difference which must occur to command consideration of learning style is not known. Identification of this magnitude is dependent on the extent to which the criteria used in assessing differences are represented in the day-to-day use of ELINOR. For example, whether the number and type of tasks are a good representation of those which would be undertaken using ELINOR, and whether the LSQ accurately represents the learning styles of the students using ELINOR. As this information is not known, the magnitude of difference necessary for consideration of learning style also remains unknown. Therefore, an assessment of whether 53 is a sufficiently large sample to detect differences in patterns of information retrieval cannot be made.

A summary of the characteristics associated with Activists, Pragmatists, Reflectors and Theorists was given in Table 3.4. A more detailed description of each learning style is provided in Appendix B. Both Activists and Pragmatists prefer to gain solutions to a problem fairly quickly. In contrast, Theorists and Reflectors are methodical in their approach, considering the problem carefully to ensure certainty in its solution. For the simple tasks, all four learning style groups were expected to display similar patterns of information retrieval behaviour. The nature of the simple tasks is such that the approach is somewhat prescribed and leaves little opportunity to explore ELINOR or undertake in-depth searching. For the complex task, Theorists and Reflectors were expected to explore ELINOR in greater depth than Activists and Pragmatists, using more documents and making use of a greater number of operational facilities. Hypothesis 1 was developed to test the theory that learning style influences patterns of information retrieval.

> *Hypothesis 1*
> *Patterns of information retrieval among users with different learning styles are similar for simple tasks, but differ for complex tasks.*

Sections 8.1.1 to 8.1.3, inclusive, provide detailed analysis of the relationship between learning style and patterns of information retrieval. Summary statistics were generated using Microsoft Excel™ (version 5.0) and used to examine the patterns of information retrieval adopted by the 53 students. Confidence intervals were used to make inferences about the patterns of information retrieval likely to be employed by the total population of Activists, Reflectors, Theorists and Pragmatists. The confidence intervals represent the range of feasible values within which the population means for the number and nature of documents and operational facilities used are likely to fall. Confidence intervals were calculated at the 95% level throughout the analysis and were generated using Minitab™ (version 11.11).

A hypothesis testing approach was not adopted within the analysis. Hypothesis testing is conducted when a limited number of hypotheses, requiring formal testing, have been specified in advance of the data collection. However, the research described in this thesis is exploratory the aim being to explore associations which may lead to more formal hypotheses for testing in future research (Altman, 1995). Furthermore, as the hypotheses stated within this research are interrelated, the outcome of any individual test cannot be taken in isolation.

A further reason for rejecting the use of hypothesis tests arises from the over-reliance which has been placed on the results of such tests. The outcome of hypothesis tests are usually reported by stating a p value. P values signify whether there is evidence to reject the hypothesis and conclude that there is statistical evidence of an effect. However, it is the size of any effect which is of practical importance within this research. This cannot be determined from p values. Confidence intervals provide an estimate of the size of any effect and, hence, convey more useful information than the p value (Altman, 1995). Therefore, confidence intervals supply a key element in interpreting the data generated within this research.

### 8.1.1 Analysis Of The Number And Nature Of Documents Used

A number of hypotheses were developed to test theories regarding the number and nature of documents expected to be used by each learning style group in each task.

> *Hypothesis 1.1*
> *For simple tasks there are similarities in the number and nature of documents used by all learning style groups.*
>
> *Hypothesis 1.2*
> *For complex tasks Reflectors and Theorists use, on average, a greater number of documents than Activists and Pragmatists.*
>
> *Hypothesis 1.3*
> *For complex tasks Reflectors and Theorists use, on average, a greater range of documents (by type) than Activists and Pragmatists.*

Tables 8.1 and 8.2 provide summary statistics for the number and nature of documents used by each learning style group in each of the three tasks. The raw data is provided in Appendix I.

Table 8.1
Summary Statistics For The Number Of Documents Used By Each Learning Style Group

| Task 1 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Activists | 1.1 | 16 | 2 | 2 |
| Reflectors | 1.3 | 13 | 3 | 3 |
| Theorists | 1.1 | 11 | 1 | 2 |
| Pragmatists | 1.0 | 6 | 0 | 1 |
| **Task 2** | **Mean No. Of Documents Used** | **No. Of Students Using 1 Document** | **No. Of Students Using More Than 1 Document** | **Maximum No. Of Documents Used** |
| Activists | 1.4 | 13 | 6 | 3 |
| Reflectors | 1.4 | 13 | 3 | 5 |
| Theorists | 1.1 | 11 | 1 | 2 |
| Pragmatists | 1.0 | 6 | 0 | 1 |
| **Task 3** | **Mean No. Of Documents Used** | **No. Of Students Using Between 1 And 5 Documents** | **No. Of Students Using Between 6 And 10 Documents** | **Maximum No. Of Documents Used** |
| Activists | 4.6 | 14 | 4 | 13 |
| Reflectors | 5.9 | 8 | 6 | 13 |
| Theorists | 6.0 | 6 | 4 | 11 |
| Pragmatists | 5.2 | 3 | 3 | 8 |

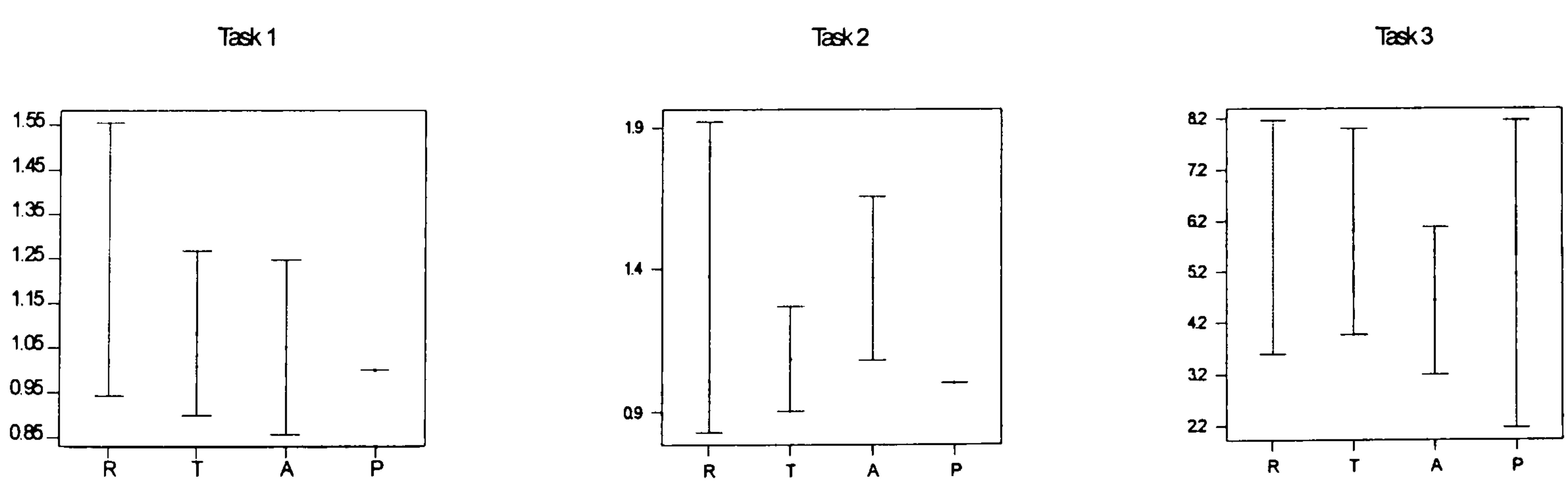
Table 8.2
Summary Statistics For The Range Of Documents (Or Number Of Document Types) Used By Each Learning Style Group

| Task 1 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Activists | 1.0 | 17 | 1 | 2 |
| Reflectors | 1.2 | 13 | 3 | 2 |
| Theorists | 1.1 | 11 | 1 | 2 |
| Pragmatists | 1.0 | 6 | 0 | 1 |
| **Task 2** | **Mean No. Of Document Types Used** | **No. Of Students Using 1 Document Type** | **No. Of Students Using More Than 1 Document Type** | **Maximum No. Of Document Types Used** |
| Activists | 1.0 | 19 | 0 | 1 |
| Reflectors | 1.0 | 16 | 0 | 1 |
| Theorists | 1.0 | 12 | 0 | 1 |
| Pragmatists | 1.0 | 6 | 0 | 1 |
| **Task 3** | **Mean No. Of Document Types Used** | **No. Of Students Using Between 1 And 5 Document Types** | **No. Of Students Using Between 6 And 10 Document Types** | **Maximum No. Of Document Types Used** |
| Activists | 2.2 | 19 | 0 | 4 |
| Reflectors | 2.4 | 16 | 0 | 4 |
| Theorists | 2.6 | 12 | 0 | 4 |
| Pragmatists | 2.3 | 6 | 0 | 4 |

Table 8.1 shows that, for Tasks 1 and 2, the differences among the mean number of documents used by each learning style group are small. The majority of students in each group used a single document. Table 8.2 also indicates small differences among learning style groups with regard to the nature or range of documents used for Tasks 1 and 2. These findings are not surprising given that the nature of the tasks leaves little opportunity for exploring the system. Table 8.1 indicates more variance among learning style groups regarding the number of documents used for Task 3; Reflectors and Theorists using slightly more documents than Activists and Pragmatists. However, Table 8.2 again indicates small differences among groups in the range of documents used for Task 3.

As stated in Section 8.1 confidence intervals were used to make inferences about the patterns of information retrieval likely to be employed by the total population of Activists, Reflectors, Theorists and Pragmatists. Confidence intervals for the mean number of documents used by each group are shown in Figure 8.1. Each member of the Pragmatist group used only one document in both Tasks 1 and 2. Therefore, the mean is 1.0 and there is no range as the values do not vary.

Figure 8.1
Confidence Intervals For The Mean Number Of Documents Used By The Total Population Of Each Learning Style Group

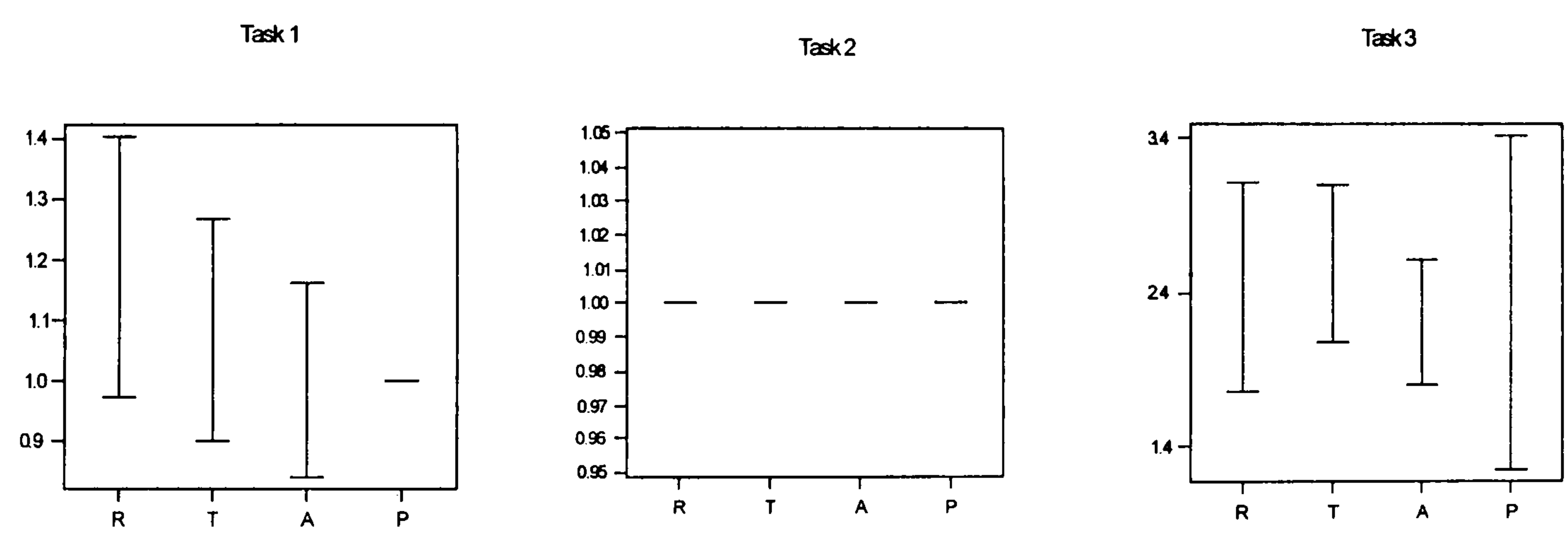



Key: R = Reflectors T = Theorists A = Activists P = Pragmatists

Figure 8.1 shows that the confidence intervals for the population means of the four groups overlap in all three tasks. This indicates little difference among learning style groups with regard to the number of documents used. A larger difference between Pragmatists and Activists in Task 2 is apparent as there is no overlap between the ranges for these groups. However, as there are only 6 Pragmatists within the sample, this difference is not conclusive.

Confidence intervals for the mean number of document types used by each group are shown in Figure 8.2. Just one document type was used by Pragmatists in Task 1 and by all groups in Task 2. Therefore, the mean is 1.0 and the values do not vary.

Figure 8.2
Confidence Intervals For The Mean Number Of Document Types Used By The Total Population Of Each Learning Style Group




Key: R = Reflectors T = Theorists A = Activists P = Pragmatists

The analysis indicates little difference in the number or nature of documents used among learning style groups in the three tasks. For simple tasks this finding is expected as the documents required to complete the task are prescribed by the task itself. Therefore evidence exists to support Hypothesis 1.1. It was expected that differences would be apparent in the number and nature of documents used between learning style groups for Task 3. However, this was not the case. Although Table 8.1 shows that Reflectors and Theorists used slightly more documents for Task 3, this is not reflected in Figure 8.1. Therefore Hypotheses 1.2 and

1.3 are not supported. The Theorist and Pragmatist learning style groups contain twelve and six members respectively. A larger number of members in these groups may provide a better indication of any differences. Hypotheses 1.2 and 1.3 state that Reflectors display similar patterns of information retrieval to Theorists and that Activists display similar patterns of information retrieval to Pragmatists. Therefore, these groups were combined in order to gain greater power with which to perform the analysis. However, analysis showed no further evidence of a difference for either the number or nature of documents used. Summary statistics and confidence intervals for the combined groups are contained in Appendices J and K, respectively.

### 8.1.2 Analysis Of The Number And Nature Of Operational Facilities Used

Hypotheses were developed to test theories regarding the number and nature of operational facilities expected to be used by each learning style group.

> *Hypothesis 1.4*
> *For simple tasks all learning style groups use a similar number and range of operational facilities.*
>
> *Hypothesis 1.5*
> *For complex tasks Reflectors and Theorists use, on average, a greater number and range of operational facilities than Activists and Pragmatists.*

Section 7.1.3 stated that software defects caused difficulty in recording the number and nature of operational facilities used in each task. In some instances, ELINOR's interface shows that actions have been performed but no operational facilities appear to have been selected by the student. In other instances, ELINOR does not respond to an action causing the student to try an alternative method for performing the same operation (where possible). System defects accounted for use of the following number of operational facilities.

| | | |
|---|---|---|
| Activists | Task 1 | 4 |
| | Task 3 | 1 |
| Reflectors | Task 1 | 3 |
| | Task 3 | 1 |

The number and nature of operational facilities used by Theorists and Pragmatists in each task and by Activists and Reflectors in Task 2 remained unaffected. The analysis described in this section excludes the use of additional operational facilities caused by system defects. A second analysis included this data in order to assess the influence of system defects on the research outcome. No influence was found. Summary statistics and confidence intervals for the analysis including the use of additional operational facilities are contained in Appendices J and K, respectively.

Table 8.3 provides summary statistics for the number and nature of operational facilities used by each learning style group in each of the three tasks. The raw data is contained in Appendix I.

Table 8.3
Summary Statistics For The Number And Nature Of Operational Facilities Used

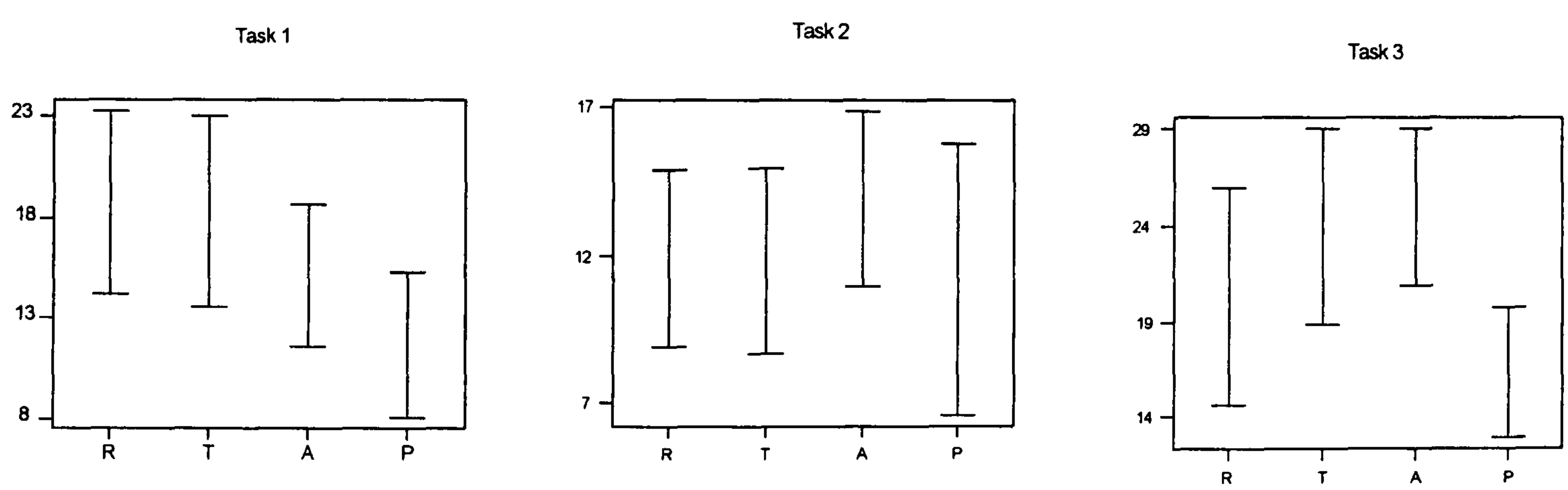
| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | Activists | 15.2 | 14 | 13 | 5 | 35 | 30 |
| | Reflectors | 18.8 | 16 | 15 | 9 | 38 | 29 |
| | Theorists | 18.3 | 17 | 17 | 8 | 32 | 24 |
| | Pragmatists | 11.7 | 11 | 11 | 7 | 17 | 10 |
| Task 2 | Activists | 13.9 | 14 | 14 | 5 | 26 | 21 |
| | Reflectors | 11.9 | 12 | 12 | 4 | 23 | 19 |
| | Theorists | 11.8 | 11.5 | 6 | 6 | 22 | 16 |
| | Pragmatists | 11.1 | 11 | 10 | 4 | 17 | 13 |
| Task 3 | Activists | 24.9 | 25 | 24 | 7 | 40 | 33 |
| | Reflectors | 20.3 | 19 | 18 | 4 | 44 | 40 |
| | Theorists | 23.9 | 23 | 22 | 13 | 36 | 23 |
| | Pragmatists | 16.3 | 17 | n/a | 12 | 20 | 8 |

Table 8.3 shows greater variance in the mean number and nature of operational facilities used by each group in each task than was observed for the number and nature of documents. There

is no modal value for the number of operational facilities used by Pragmatists in Task 3 as each member of this group used a different quantity. On average, Theorists and Reflectors used slightly more operational facilities for Task 1. This difference was expected for the complex task only. The data for Task 3 show that Pragmatists used fewest operational facilities, whereas Activists, Reflectors and Theorists used a similar amount.

Confidence intervals (shown in Figure 8.3) were generated in order to explore any differences between the total population of Activists, Reflectors, Theorists and Pragmatists regarding the number and nature of operational facilities used.

Figure 8.3
Confidence Intervals For The Mean Number And Nature Of Operational Facilities Used By The Total Population Of Each Learning Style Group




Key: R = Reflectors T = Theorists A = Activists P = Pragmatists

The confidence intervals for the population means of the four groups overlap for Tasks 1 and 2. This indicates that all learning style groups are likely to use a similar number of facilities in the simple tasks. This provides evidence to support Hypothesis 1.4. The intervals also overlap for Task 3 except in the case of Pragmatists and Activists, suggesting that there may be a difference between these two groups. However, it was expected that similar patterns would occur between Activists and Pragmatists. Therefore Hypothesis 1.5 is not supported.

Reflectors were again combined with Theorists, and Activists combined with Pragmatists, in order to achieve greater power with which to perform the analysis. Summary statistics and confidence intervals for the combined groups are contained in Appendices J and K, respectively. Analysis showed no further evidence of a difference in the number and nature of operational facilities used.

### 8.1.3 Use Of The Search And Fileroom Facilities

In assessing the use of each operational facility, particular reference was given to the Search and Fileroom facilities: the two approaches to retrieving information currently provided by ELINOR. The Search facility uses clue words to search the whole of ELINOR's content. In contrast, the more structured Fileroom approach allows documents to be located through a hierarchy of menus relating to document type (e.g. books or journals) and subject area (Section 2.3.2). A number of hypotheses were developed to examine theories regarding the preferences of each learning style group for both the Search and Fileroom facilities. Activists have a tendency to take immediate, obvious actions preferring to collect lots of information before adding structure and theory. For complex tasks, it was expected that they would prefer the Search facility. The more methodical Theorists were expected to prefer the Fileroom facility. The objective of Pragmatists is to complete the task. They were expected to have no preference for either the Search or Fileroom facility. Reflectors, who observe problems from many different perspectives, were also expected to have no preference, making use of both the Search and Fileroom facilities. As explained previously, simple tasks are somewhat prescribed in nature and leave little scope for exploring the system or undertaking in-depth searching. For simple tasks Activists were expected to prefer the Search facility whilst Reflectors and Theorists were expected to prefer the Fileroom facility. Pragmatists were expected to have no preference for either facility. The hypotheses developed with regard to the Search and Fileroom facilities are as follows.

*Hypothesis 1.6*
*For simple tasks Activists prefer the Search facility, Theorists and Reflectors prefer the Fileroom facility, and Pragmatists have no apparent preference for either the Search or Fileroom facilities.*

*Hypothesis 1.7*
*For complex tasks Activists prefer the Search facility and Theorists prefer the Fileroom facility. Pragmatists and Reflectors have no apparent preference for either the Search or Fileroom facilities.*

Raw data for the use of the Search and Fileroom facilities is provided in Appendix I. Table 8.4 provides the average number of times these facilities were used by each learning style group in each task.

Table 8.4
Average Number Of Times The Search And Fileroom Were Used By Each Learning Style Group

| | Search | | | Fileroom | | |
|---|---|---|---|---|---|---|
| Learning Style | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| Activists | 1.8 | 1.7 | 10.3 | 0.8 | 1.3 | 2.1 |
| Pragmatists | 2.5 | 1.2 | 10.5 | 0.5 | 0.8 | 0.2 |
| Reflectors | 2.7 | 1.1 | 10.2 | 1.3 | 1.4 | 1.3 |
| Theorists | 3.2 | 1.3 | 12.3 | 2.3 | 1.4 | 2.1 |

Table 8.4 shows that all learning style groups have a preference for the Search facility in Tasks 1 and 3. For Task 2 Activists and Pragmatists also prefer the Search facility, whilst Reflectors and Theorists have a slight preference for the Fileroom. However, the preferences of all learning style groups are less marked for Task 2 than for Tasks 1 and 3. Therefore, Hypothesis 1.6 is supported with regard to the behaviour of Activists in Tasks 1 and 2 and Theorists and Reflectors in Task 2. Hypothesis 1.7 is supported by the data in only one instance: the fact that Activists prefer the Search facility for complex tasks. It is not supported for any of the other learning style groups.

ELINOR's Search facility operates in a similar way to the OPAC, CD ROM and database facilities available to students within De Montfort University. Therefore, experience in using these facilities may influence the way in which students approach searches within ELINOR. The extent to which search experience and computer literacy influenced the research outcome is discussed in Section 8.3. Search experience and computer literacy were assessed using the frequency with which a number of information sources (including OPAC and CD ROM) and computer applications (including databases) were used. Frequency of use was described as "always", "sometimes", "rarely", or "never". However, use of the OPAC, CD ROM and database facilities has been considered more specifically in determining whether frequency of use influenced choice of ELINOR's Search facility. Analysis revealed little influence. The majority of students within each learning style group stated that they used the CD ROM and database facilities only sometimes or rarely. The majority of Activists, Reflectors and Theorists stated that they used the OPAC sometimes whereas the responses of Pragmatists were equally split between the categories "sometimes", "rarely" and "never". Greater detail regarding the frequency with which learning style groups used the OPAC, CD ROM and database facilities is contained in Appendix L.

## 8.2 ELINOR's Ability To Support The Information Retrieval Activities Associated With Different Learning Styles

A further objective of the research is to ascertain whether ELINOR can support the information retrieval activities associated with different learning styles (Section 5.1). A general indication of whether ELINOR appeals to each learning style group was gained through responses to Question 1 of the evaluation questionnaire (described in Section 7.2.1). Figure 8.4 summarises these responses.

Figure 8.4
Attitudes Of Each Learning Style Group Towards ELINOR

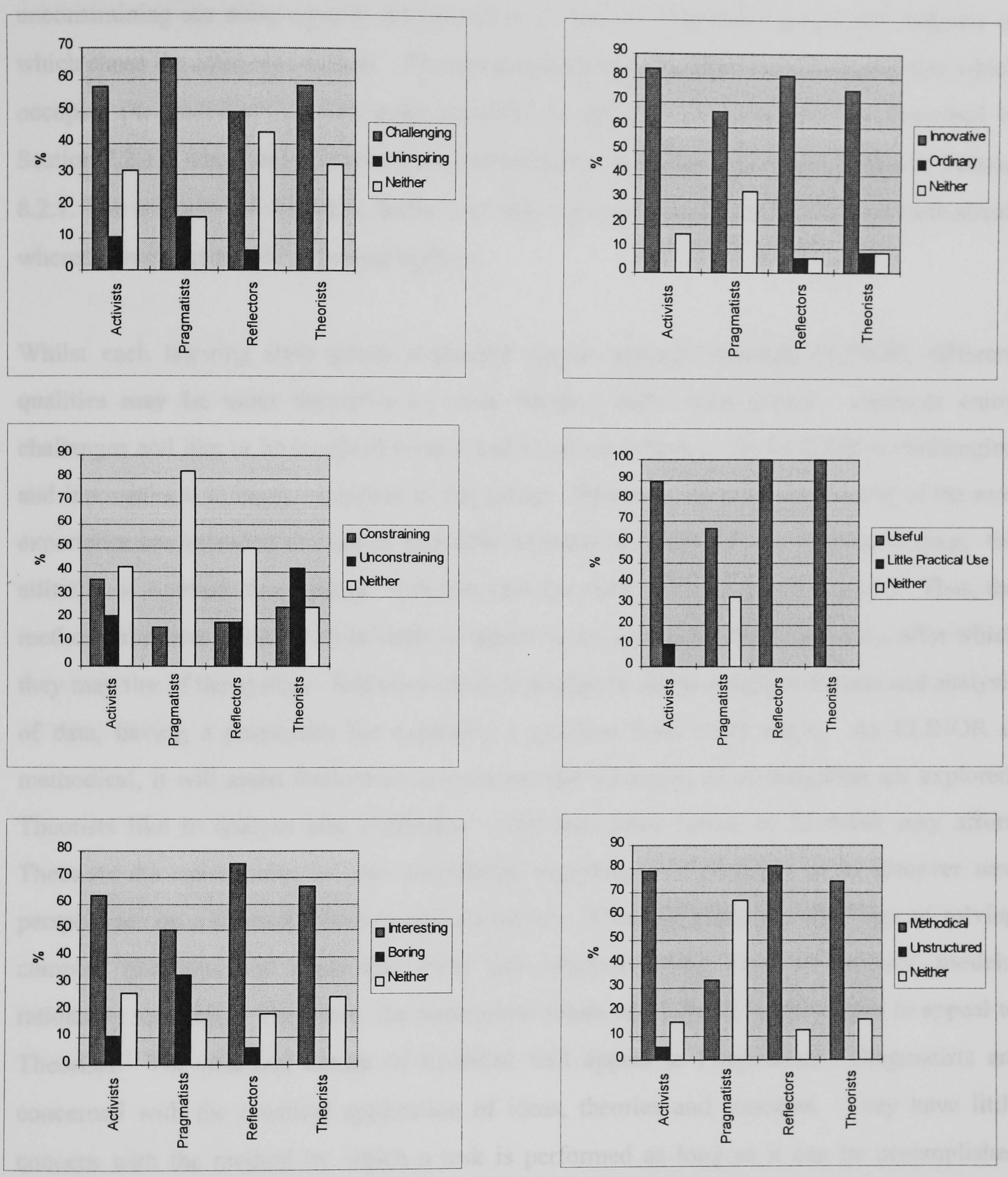


Figure 8.4 illustrates that, on average, students found ELINOR to be challenging, innovative, useful and interesting. The attitudes regarding whether ELINOR is constraining or unconstraining are more equally distributed in all but the Pragmatist group, the majority of which chose the category "neither". The categories labelled "neither" refer to a response which occupies the midpoint on each scale provided by Question 1 (Question 1 is described in Section 7.2.1). The level of constraint experienced by students is discussed further in Section 8.2.1. The majority of Activists, Reflectors and Theorists described ELINOR as methodical, whereas Pragmatists held no strong opinion.

Whilst each learning style group expressed similar attitudes towards ELINOR, different qualities may be more attractive to some learning styles than others. Activists enjoy challenges and like to be involved in new and novel experiences. As ELINOR is challenging and innovative it is likely to appeal to this group. However, once the excitement of the new experience has subsided and use of ELINOR becomes more routine and less challenging, the attitudes of Activists may change. Activists also tire easily of method and structure. Thus, the methodical nature of ELINOR is likely to appeal to Activists for a short time only, after which they may tire of the system. Reflectors tend to engage in the thorough collection and analysis of data, having a propensity for exploring a problem from every angle. As ELINOR is methodical, it will assist Reflectors in ensuring that all angles of investigation are explored. Theorists like to analyse and synthesise. The innovative nature of ELINOR may afford Theorists the opportunity to gain knowledge regarding new concepts or to discover new perspectives on a concept which is already known. Theorists enjoy the challenge of solving complex problems and appreciate order and structure, being keen on theories, models, rationality and logic. Therefore, the methodical nature of ELINOR is also likely to appeal to Theorists. The practical nature of ELINOR will appeal to Pragmatists. Pragmatists are concerned with the practical application of ideas, theories and concepts. They have little concern with the method by which a task is performed as long as it can be accomplished successfully.

### 8.2.1 ELINOR's Provision Of Document Content And Operational Facilities

ELINOR's ability to support the information retrieval activities of different learning style groups was assessed, more specifically, in terms of its document content and operational facilities. Hypothesis 2 was developed to test the theory that ELINOR differs in its ability to support the information retrieval activities of Activists, Reflectors, Theorists and Pragmatists over the three tasks.

> *Hypothesis 2*
> *The functionality of ELINOR facilitates one or more aspects of the information retrieval activities of one or more learning style groups for one or more tasks but is constraining for other learning style groups in other aspects for other tasks.*

Activists like to be in control of their work and do not like to be constrained in their approach. Reflectors require a thorough, detailed collection of data to allow all possible angles to be considered before reaching a conclusion. Theorists require principles, concepts and models to fit into a rational scheme. They like to maximise certainty and be stretched intellectually. Pragmatists focus their attention on completing the task but may feel constrained if they cannot complete it satisfactorily.

The document content of ELINOR is somewhat limited, inclusion of documents being dependent on the negotiation of copyright issues with publishers. For all learning style groups the completion of the simple tasks was expected to be adequately provided for by ELINOR's document content. However, for the complex task, each group was expected to experience constraint in their use of ELINOR as a consequence of the system's limited content. Hypotheses 2.1 and 2.2 were developed to test these theories.

> *Hypothesis 2.1*
> *All learning style groups (Activists, Reflectors, Theorists and Pragmatists) will be constrained in their use of ELINOR as a consequence of its limited content in terms of the number of documents. This is true for complex tasks but not for simple tasks.*

*Hypothesis 2.2*
*All learning style groups (Activists, Reflectors, Theorists and Pragmatists) will be constrained in their use of ELINOR as a consequence of its limited content in terms of the nature of documents. This is true for complex tasks but not simple tasks.*

Within ELINOR, there is no prescribed method of searching for a document, and tasks may be completed in a variety of ways. Therefore, it was expected that no learning style group would be constrained by the system's operational facilities. Hypothesis 2.3 was developed to test this theory.

*Hypothesis 2.3*
*None of the user groups (Activists, Reflectors, Theorists and Pragmatists) will be constrained in their use of ELINOR as a consequence of its operational facilities. This is true for both simple and complex tasks.*

Data regarding constraint by ELINOR's document content and operational facilities was collected by the evaluation questionnaire (described in Sections 6.8.2 and 7.2.1). The raw data is included in Appendix I. The proportion of students constrained by ELINOR's document content was found for both simple and complex tasks. The findings are presented in Figure 8.5.

Figure 8.5
Percentage Of Students Constrained By ELINOR's Document Content

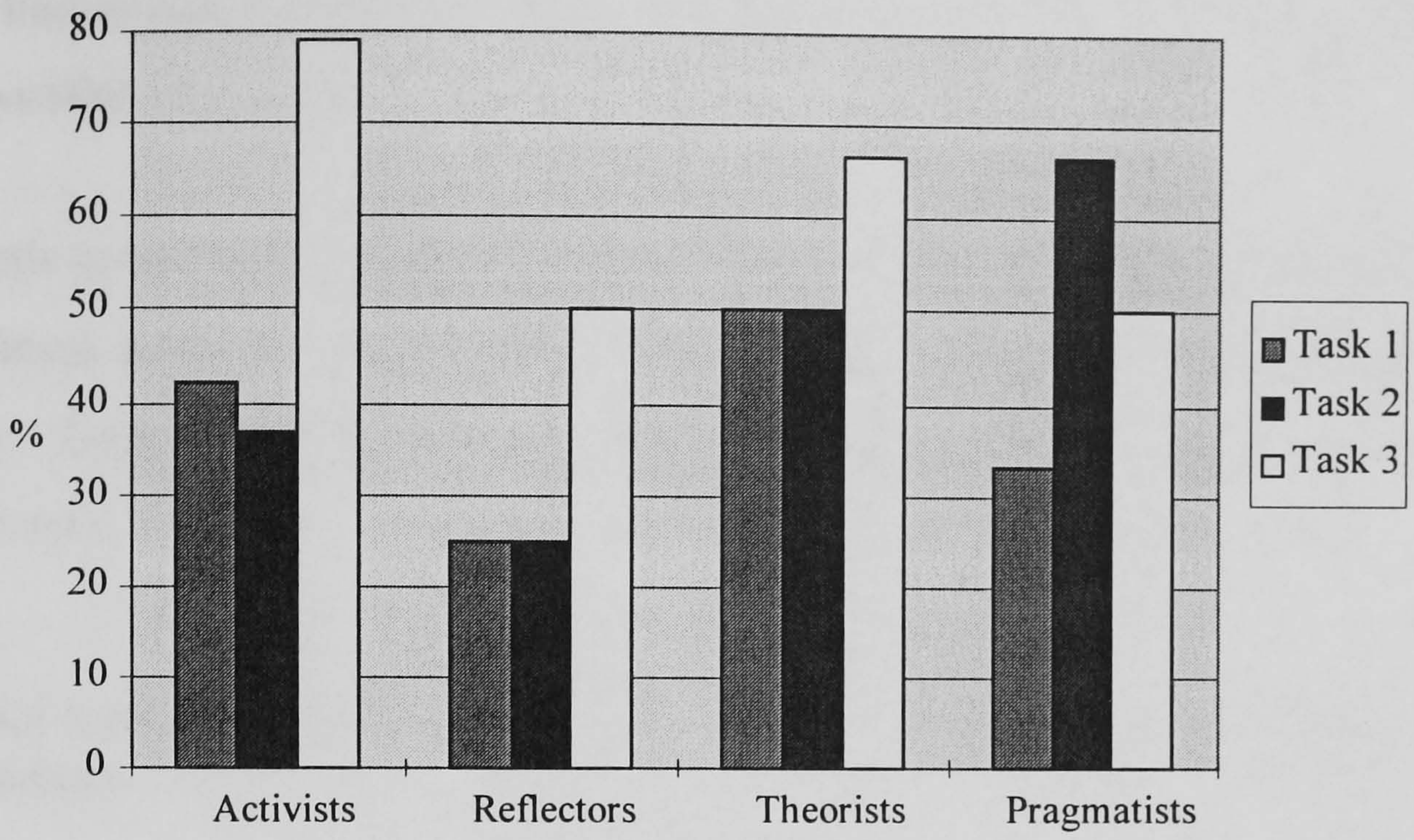



Figure 8.5 indicates that all learning style groups were constrained in all three tasks by ELINOR's document content. Most constraint was felt in Task 3 for all groups with the exception of Pragmatists. This is not surprising given that this task was of a more complex nature. It is interesting to note the high levels of constraint experienced by Theorists in Task 1 and both Theorists and Pragmatists in Task 2: 50% or more reporting constraint in each case. Given that the tasks were designed with ELINOR's document content in mind, this finding is unexpected. However, in completing the evaluation questionnaire, a number of students omitted to relate their answers to the task, and responses reflected more general attitudes towards ELINOR's document content (Section 7.2.2).

Table 8.1 showed that Activists used, on average, the least number of documents for Task 3 although there was little difference between any of the groups with regard to this aspect. Figure 8.5 shows that Activists also felt most constrained by ELINOR's document content for this task. This may reflect the information retrieval behaviour of this group. Activists are characterised as being enthusiastic but become easily bored. This group may not have viewed each document in enough depth to judge its relevance accurately, discounting the document as useless after a few moments. Therefore, Activists may have discarded many of the documents containing information needed for the task and, as a consequence, felt constrained from an inability to find enough information. Within ELINOR the document content may be altered to avoid this possible constraint.

Some students stated a preference for more documents in order to complete one or more tasks. Others preferred fewer documents, being constrained by having to search through too much information. Table 8.5 shows the percentage of students in each learning style group with these preferences.

Table 8.5
Percentage Of Students In Each Learning Style Group With Preferences For Greater And Fewer Documents

| | Greater | | | Fewer | | |
|---|---|---|---|---|---|---|
| Learning Style | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| Activists | 57.9 | 36.8 | 73.7 | 10.5 | 10.5 | 47.4 |
| Reflectors | 12.5 | 18.8 | 37.5 | 6.3 | 6.3 | 6.3 |
| Theorists | 33.4 | 33.4 | 25.0 | 25.0 | 25.0 | 33.4 |
| Pragmatists | 33.4 | 66.7 | 33.4 | 0 | 16.7 | 16.7 |

The data show that, overall, students preferred to have a greater number of documents. This preference is highest within the Activist group for Tasks 1 and 3 and within the Pragmatist group for Task 2. The highest preference for fewer documents is held by Theorists in Tasks 1 and 2 and Activists in Task 3.

The evaluation questionnaire asked students to indicate which types of document should be included or excluded in order to ascertain whether each learning style group was also constrained by the nature of the documents contained within ELINOR. Those students indicating a preference for more documents stated that ELINOR should provide a greater number of one or more document types already present within the system. No student indicated that the additional documents should be of a different type than those already contained within ELINOR. Thus it would seem that these students are not constrained by the nature of ELINOR's documents. In contrast, those students indicating a preference for fewer documents stated that certain document types already present within ELINOR should be excluded. Although Pragmatists experienced no constraint from the nature of ELINOR's document content in Task 1, Hypotheses 2.1 and 2.2 are supported for complex tasks, but not simple tasks. However, this conclusion must remain tentative as students did not complete the evaluation questionnaire as required. Greater detail regarding students' preferences regarding the type of documents contained within ELINOR is given in Appendix M.

The proportion of students constrained by ELINOR's operational facilities was found for both simple and complex tasks. The number of students constrained was ascertained by responses to the evaluation questionnaire which asked students to indicate whether ELINOR's operational facilities were adequate for completion of each task. However, a number of students omitted to state the task to which their comments referred and hence could not be classified as constrained or unconstrained for the task or tasks in question (Section 7.2.2). The number of students who could not be classified in one or more tasks, and their respective learning styles, are given in Table 8.6.

Table 8.6
The Number Of Students In Each Learning Style Group Who Could Not Be Classified As Constrained Or Unconstrained By Operational Facilities

| Learning Style | *Task 1* | *Task 2* | *Task 3* |
|---|---|---|---|
| Activists | 1 | 2 | 1 |
| Reflectors | 3 | 3 | 4 |
| Theorists | 1 | 0 | 0 |
| Pragmatists | 1 | 1 | 0 |

Figure 8.6 shows the percentage of students constrained in each task by ELINOR's operational facilities. The percentages have been calculated excluding those students who could not be classified.

Figure 8.6
Percentage Of Students Constrained By ELINOR's Operational Facilities

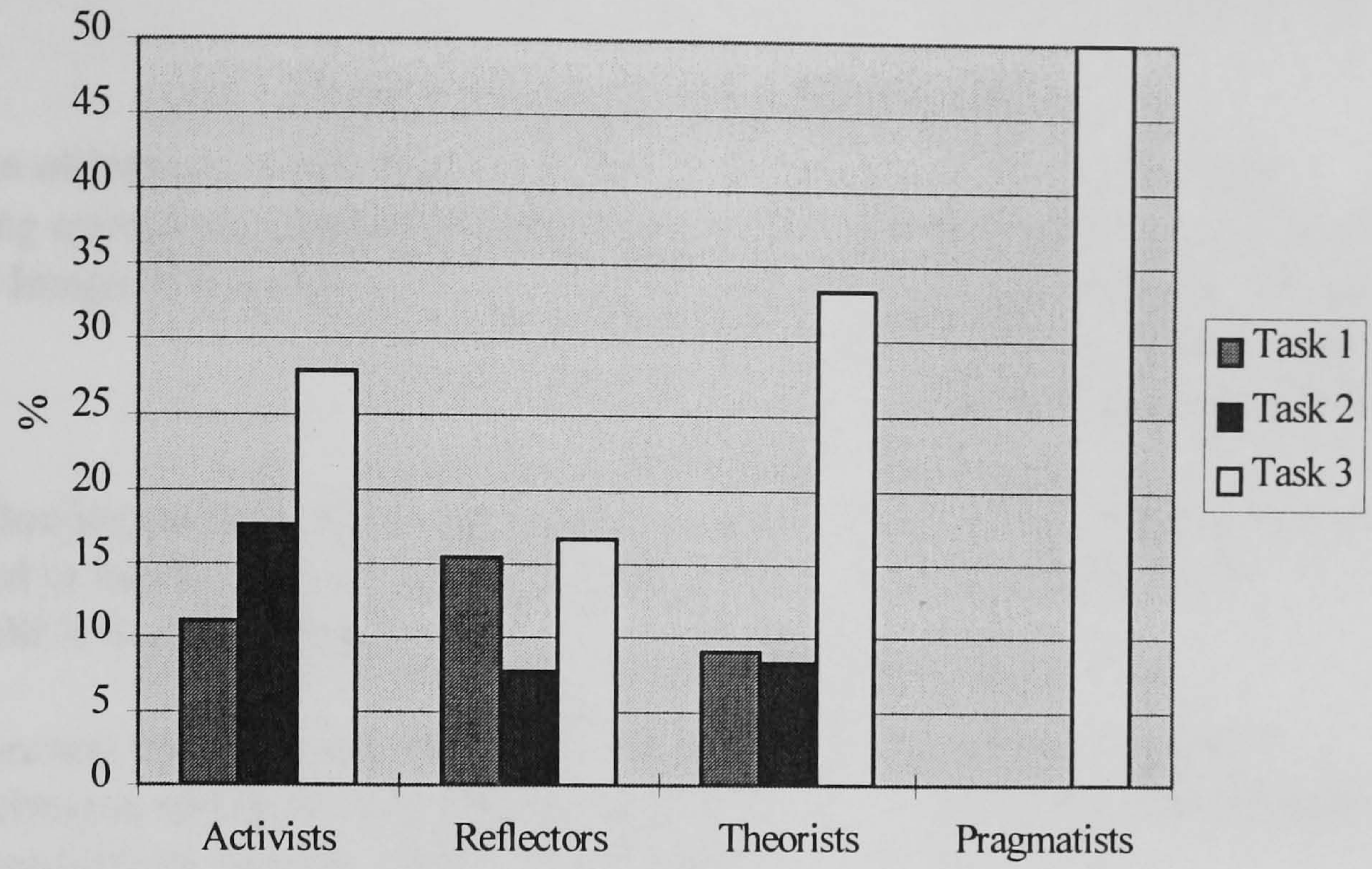



Figure 8.6 indicates that constraint from ELINOR's operational facilities was felt by all learning style groups in all three tasks with the exception of Pragmatists who experienced no constraint in Tasks 1 or 2. Therefore, Hypothesis 2.3 is unsupported in all instances with the exception of Pragmatists in the simple tasks. Pragmatists experienced more constraint than any other group in Task 3. Table 8.3 showed that, on average, Pragmatists used the least number of operational facilities for Task 3. As Pragmatists are quite focused on the task, they may not have taken time to explore ELINOR's operational facilities in enough depth to discover any which might have helped them over and above those taught in the training programme. Therefore, the level of constraint experienced by Pragmatists may have been a consequence of their learning style. However, the views of Pragmatists regarding additional operational facilities suggests that constraint resulted from ELINOR's functionality.

The evaluation questionnaire asked students to describe any additional operational facilities which would have helped them in the tasks, or any facilities which should be excluded from ELINOR. The responses are summarised as follows.

| | |
|---|---|
| A facility allowing bibliographic information to be found quickly and easily. | 1 Activist, Task 1<br>2 Activists, Task 3<br>1 Reflector, Task 1<br>1 Reflector, no task specified |
| The provision of buttons, rather than menus, for performing operations, particularly within the Text and Image Windows. | 1 Activist, all tasks<br>2 Activists, no task specified<br>1 Pragmatist, no task specified<br>1 Theorist, no task specified<br>1 Reflector, no task specified |
| An option allowing specific document types to be included or excluded from the hit list when using ELINOR's Search facility. | 1 Activist, Tasks 2 and 3<br>1 Theorist, Task 3 |
| ELINOR's present functionality includes a fuzzy searching technique which retrieves hits containing both exact matches and similar matches to the clue words entered (Section 2.3.3). The ability to include within the hit list only exact matches to the clue words entered was required. | 1 Reflector, Task 3<br>1 Activist, no task specified |
| A facility allowing multiple documents to be viewed simultaneously. | 1 Activist, Task 3 |
| An option which records the sequence in which pages have been viewed and allows pages viewed earlier to be revisited quickly and easily. | 1 Activist, no task specified<br>1 Pragmatist, Task 3 |
| An option allowing the contents page of a document to be viewed at the touch of a button. | 1 Reflector, no task specified |
| A facility for searching using Boolean operators. | 1 Pragmatist, Task 3<br>1 Activist, no task specified |
| Within ELINOR, the Go To Page option allows the user to jump straight to specific pages by entering a page number (Section 2.3.5). The ability to jump to a specific type of page by entering the name of a page rather than a page number was suggested. Types of page include the contents or index pages. | 1 Pragmatist, Task 3 |

| | |
|---|---|
| The ability to search for information within documents. | 1 Reflector, Task 3<br>1 Pragmatist, no task specified |
| A facility allowing users to perform single or multiple searches using bibliographic information as the search criteria. For example, searching by author, author and title, or title and publication date. This functionality is similar to that of many OPAC systems (Section 2.4.1). | 1 Reflector, Task 1<br>1 Theorist, Task 3<br>1 Activist, Task 3 |
| Where a user wishes to view a page in text format but no text page is available, he/she must view the page in image format (Section 2.3.5). It was suggested that an option for viewing the image page be included within the error box that indicates when there is no text page available. | 1 Reflector, Task 3<br>1 Reflector, no task specified |
| Task 1 required students to find the author of the document entitled "Expert Systems: Tools and Applications" (Section 6.7). It was suggested that the ability to find out what type of document this was would be useful. | 1 Theorist, Task 1 |
| Within ELINOR's Search facility an option for limiting the hit list to documents within one particular filing cabinet. | 1 Theorist, Task 2 |
| The provision of links from the contents pages of documents to the corresponding pages within the document. | 1 Theorist, Task 3<br>1 Reflector, no task specified |
| Facilities requested, but not specifically described, which provide the ability to reduce the number of hits generated by the search, the ability to constrict the search more or more comprehensive search options. | 1 Reflector, Task 3<br>1 Activist, Task 3<br>1 Activist, no task specified<br>1 Theorist, Task 1 |

Only one student, a Theorist, preferred fewer operational facilities, stating that the manipulation of image pages by rotation was not useful. Possible extensions to ELINOR's functionality in order to meet students' requirements are discussed in Section 9.4.

Several of the responses indicate the requirement for operational facilities already provided by ELINOR. This is also discussed in Section 9.4.

## 8.3 Analysis Of The Information Retrieval Patterns And Preferences Associated With Characteristics Other Than Learning Style

Previous research into individual differences and information retrieval indicates the existence of a wide variety of characteristics other than learning style which may influence the behaviour of ELINOR's user population (Allen, 1991; Balaraman, 1991; Borgman, 1989; Fowler and Murray, 1987; Hsieh-Yee, 1993). These characteristics, and the measures taken to avoid bias from their influence within this research, were discussed Section 6.4. However, for some characteristics, individual differences were allowed to remain until the number of students willing to take a further part in the research was established (Section 6.5). These characteristics were: gender, ethnic origin, social class, computer affinity, search experience and computer literacy. The final sample comprised 53 students. If variation within any of these characteristics were excluded the research would be based on too few students. Subsequent statistical analysis was undertaken to assess the effect of any influence from these characteristics on the research outcome.

Data regarding variation in gender, ethnic origin, social class, computer affinity, search experience and computer literacy was gathered through a pre-test questionnaire (described in Section 6.4.2). In the case of gender and ethnicity students could be easily categorised from their responses to the pre-test questionnaire. However, care was required in identifying groupings within the data regarding social class, computer affinity, search experience and computer literacy.

Social class was determined on the basis of the most recent occupation of the head of the students' household using the Standard Occupational Classification (Vols. 1 and 2, 1992; Vol. 3, 1991).

Computer affinity was determined by coding responses to statements provided in the pre-test questionnaire. The statements were as follows.

- I enjoy using computers.
- I am indifferent about using computers.
- I only use computers when I have to.
- I avoid using computers at all.

Students were asked to indicate which statement best described their feelings about using computers. If a student agreed with the statement "I enjoy using computers" they were classified as having high computer affinity. If the response indicated "I am indifferent about using computers", the student was classified as having moderate computer affinity. A positive response to the statement "I only use computers when I have to" indicated low computer affinity. No students responded to the final statement "I avoid using computers at all", thus the three categories of low, moderate and high were appropriate.

Search experience was determined by the frequency with which a number of information sources (listed in Table 8.7) were used. Computer literacy was determined by the frequency with which various aspects of computer operation (also listed in Table 8.7) were used.

Table 8.7
The Information Sources And Aspects Of Computer Operation Selected In Determining Search Experience And Computer Literacy

| Information Sources | Aspects Of Computer Operation |
|---|---|
| OPAC | Windows |
| CD ROM | Mouse |
| Internet | Word Processor |
| BIDS | Spreadsheet |
| Microfilm | Database |
| Paper Sources (books, journals, etc.) | Graphics Packages |

The pre-test questionnaire required students to indicate whether they used each information source and aspect of computer operation "always", "sometimes", "rarely", or "never". A wide variety of responses were given. Therefore, analysis was employed to identify groupings within the data and enable students to be categorised more generally. The majority of students indicated that they used the Windows operating environment and mouse "always". The majority of students also stated that they very rarely used the BIDS and Microfilm information sources, if at all. Therefore, data regarding the use of Windows, mouse, BIDS and Microfilm was excluded from the analysis. The remaining information sources and aspects of computer operation (which comprised various computer applications) were used to varying degrees. The analysis used a weighting mechanism to group students in terms of whether they possessed high, moderate or low search experience and computer literacy. Separate analyses were undertaken for information sources and computer applications. Weights were allocated on the basis of how frequently a source or application was used. Five different sets of weights were employed to ascertain whether the value of the weights used influenced the groupings. The different ways of weighting resulted in essentially the same classification. A more detailed account of the method employed in ascertaining search experience and computer literacy is described in Appendix H.

The final grouping of students by characteristic and the relative membership of each group is shown in Table 8.8. The figures included within the column "Percentage of Total Population" have been rounded to one decimal place. As a result the sum of the percentages for each characteristic may not always equal 100.

Table 8.8
Characteristics Studied And Membership Of Their Respective Groups

| Characteristic | Group | Membership | % of Total Population |
|---|---|---|---|
| Gender | Females | 16 | 30.2 |
| | Males | 37 | 69.8 |
| Ethnicity | Asians | 19 | 35.9 |
| | Europeans | 33 | 62.3 |
| | Africans | 1 | 1.9 |
| Social Class | 1 | 10 | 18.9 |
| | 2 | 24 | 45.3 |
| | 3 | 17 | 32.1 |
| | 4 | 2 | 3.8 |
| Computer Affinity | High | 46 | 86.8 |
| | Moderate | 4 | 7.6 |
| | Low | 3 | 5.7 |
| Search Experience | High | 11 | 20.8 |
| | Moderate | 38 | 71.7 |
| | Low | 4 | 7.6 |
| Computer Literacy | High | 24 | 45.3 |
| | Moderate | 28 | 52.8 |
| | Low | 1 | 1.9 |

Analysis of the information retrieval patterns and attitudes associated with the characteristics in Table 8.8 was undertaken using the method employed with regard to learning style. Some groups comprise few members. These groups are: Africans; Social Class 4; Moderate Computer Affinity; Low Computer Affinity; Low Search Experience and; Low Computer Literacy. These groups do not provide enough data with which to perform an analysis of the information retrieval patterns and attitudes associated with them. There are two methods of treating the data for these groups. Firstly, the groups may be excluded from the analysis. Alternatively, the analysis may be performed when the groups are combined with other groups. Within this research, both methods were undertaken, allowing any influence from the treatment of the data to be assessed. Regarding the combined groups, Africans were combined with Asians and Social Class 4 was combined with Social Class 3. The groups bearing Low and Moderate Search Experience were combined, as were the groups bearing Low and Moderate Computer Literacy. The groups bearing High, Moderate and Low Computer Affinity were also combined.

Summary statistics and confidence intervals were employed in exploring any differences in the patterns of information retrieval adopted among groups. These are contained in Appendices J and K respectively. Findings revealed that none of the characteristics influence patterns of information retrieval for any task. This finding was consistent when excluding groups with low membership and when combining groups, indicating no influence from the treatment of the data.

Use of the Search and Fileroom facilities by each group was also examined. Raw data for the number of times both facilities were used by each individual in each task is contained in Appendix I. Table 8.9 shows the average number of times the Search and Fileroom facilities were used by each group when excluding groups with low membership and when combining groups.

Table 8.9
Average Number Of Times Search And Fileroom Used By Demographic Groups

| | Search | | | Fileroom | | |
|---|---|---|---|---|---|---|
| Excluding Groups With Few Members | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 |
| Females | 2.4 | 1.0 | 8.3 | 2.1 | 1.6 | 1.9 |
| Males | 2.5 | 1.5 | 11.8 | 0.9 | 1.2 | 1.5 |
| Asians | 2.6 | 1.0 | 8.3 | 1.5 | 0.9 | 1.5 |
| Europeans | 2.4 | 1.6 | 12.4 | 1.1 | 1.5 | 1.7 |
| Social Class 1 | 2.7 | 0.7 | 12.9 | 1.6 | 2.2 | 0.8 |
| Social Class 2 | 2.1 | 1.4 | 11.3 | 0.6 | 1.1 | 1.9 |
| Social Class 3 | 3.1 | 1.9 | 9.4 | 1.9 | 0.9 | 1.5 |
| High Computer Affinity | 2.6 | 1.3 | 11.1 | 1.2 | 1.4 | 1.6 |
| High Search Experience | 2.5 | 1.4 | 9.6 | 0.9 | 0.6 | 1.7 |
| Moderate Search Experience | 2.4 | 1.3 | 10.5 | 1.3 | 1.5 | 1.6 |
| High Computer Literacy | 2.6 | 1.5 | 10.3 | 1.5 | 1.0 | 1.6 |
| Moderate Computer Literacy | 2.4 | 1.3 | 11.3 | 1.1 | 1.5 | 1.6 |
| Combined Groups | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 |
| Asians and Africans | 2.6 | 1.0 | 8.0 | 1.6 | 0.9 | 1.4 |
| Social Classes 3 and 4 | 2.8 | 1.7 | 8.9 | 1.9 | 1.1 | 1.6 |
| High, Moderate and Low Computer Affinity | 2.5 | 1.4 | 10.7 | 1.3 | 1.3 | 1.6 |
| Moderate and Low Search Experience | 2.5 | 1.4 | 11.0 | 1.4 | 1.5 | 1.6 |
| Moderate and Low Computer Literacy | 2.3 | 1.3 | 11.0 | 1.1 | 1.5 | 1.6 |

Each group of participants has a preference for the Search facility in Tasks 1 and 3. Approximately equal preferences are apparent in Task 2. No influence from differences in the treatment of the data was apparent.

The ability of ELINOR to support the information retrieval activities of each group was also examined. Raw data for the constraint experienced by each student in each task is included in Appendix I. Tables 8.10 and 8.11 illustrate the percentage of students constrained by ELINOR's document content and operational facilities, respectively.

Table 8.10
Percentage Of Students Constrained By Document Content

| Excluding Groups With Few Members | Task 1 | Task 2 | Task 3 |
|---|---|---|---|
| Females | 31.3 | 12.5 | 37.5 |
| Males | 40.5 | 51.4 | 75.7 |
| Asians | 52.6 | 47.4 | 84.2 |
| Europeans | 30.3 | 36.4 | 54.5 |
| Social Class 1 | 20.0 | 50.0 | 40.0 |
| Social Class 2 | 45.8 | 45.8 | 87.5 |
| Social Class 3 | 41.2 | 29.4 | 47.1 |
| High Computer Affinity | 32.6 | 41.3 | 67.4 |
| High Search Experience | 54.5 | 72.7 | 63.6 |
| Moderate Search Experience | 34.2 | 31.6 | 68.4 |
| High Computer Literacy | 37.5 | 41.2 | 79.2 |
| Moderate Computer Literacy | 35.7 | 39.3 | 50.0 |
| **Combined Groups** | **Task 1** | **Task 2** | **Task 3** |
| Asians and Africans | 50.0 | 45.0 | 80.0 |
| Social Classes 3 and 4 | 36.8 | 26.3 | 47.4 |
| High, Moderate and Low Computer Affinity | 37.7 | 39.6 | 64.2 |
| Moderate and Low Search Experience | 33.4 | 31.0 | 64.3 |
| Moderate and Low Computer Literacy | 37.9 | 37.9 | 51.7 |

Table 8.11
Percentage Of Students Constrained By Operational Facilities

| Excluding Groups With Few Members | Task 1 | Task 2 | Task 3 |
|---|---|---|---|
| Females | 6.3 | 0.0 | 6.3 |
| Males | 12.9 | 16.1 | 40.6 |
| Asians | 11.1 | 5.6 | 33.3 |
| Europeans | 7.1 | 13.8 | 27.6 |
| Social Class 1 | 0.0 | 10.0 | 44.4 |
| Social Class 2 | 15.0 | 15.8 | 38.1 |
| Social Class 3 | 12.5 | 6.3 | 12.5 |
| High Computer Affinity | 10.0 | 12.5 | 34.1 |
| High Search Experience | 20.0 | 30.0 | 60.0 |
| Moderate Search Experience | 9.1 | 6.1 | 20.6 |
| High Computer Literacy | 13.6 | 9.5 | 33.3 |
| Moderate Computer Literacy | 8.3 | 12.0 | 26.9 |
| **Combined Groups** | **Task 1** | **Task 2** | **Task 3** |
| Asians and Africans | 15.8 | 5.6 | 31.6 |
| Social Classes 3 and 4 | 11.1 | 5.6 | 11.1 |
| High, Moderate and Low Computer Affinity | 10.6 | 10.6 | 29.2 |
| Moderate and Low Search Experience | 8.1 | 5.4 | 21.1 |
| Moderate and Low Computer Literacy | 8.0 | 11.5 | 25.9 |

The majority of groups were more constrained in Task 3 than either Tasks 1 or 2. This is true when considering constraint from both ELINOR's document content and operational facilities. However, those within the groups labelled "Social Class 1" and "High Search Experience" found the document content to be most constraining in Task 2. Females and those within the Social Class 3 group found the operational facilities provided by ELINOR to be equally constraining in Tasks 1 and 3. All groups, excepting Social Class 1, experienced greater constraint from ELINOR's document content than from its operational facilities. Little influence from differences in the treatment of the data was apparent.

Findings regarding the information retrieval patterns and attitudes associated with each characteristic are similar to those for learning style. This suggests that the research outcome was not influenced from differences in the demographic characteristics studied. However, the similarity in findings also suggests there may be a further factor influencing preferences other than those studied within this research.

## Summary

This chapter described the methods employed in analysing the data from the research and the research findings. Findings suggest little influence of learning style on patterns of information retrieval from ELINOR. No indication of a relationship was found between learning style and the number and nature of documents or operational facilities used for any of the tasks included within this research. Analysis regarding use of the Search and Fileroom facilities revealed that all learning style groups preferred the Search facility in Tasks 1 and 3. However, a possible relationship between learning style and use of the Search and Fileroom facilities was found for Task 2.

The ability of ELINOR's functionality to support the information retrieval activities of different learning style groups was also considered. Analysis indicates that all learning style groups found ELINOR's document content insufficient for successful completion of both simple and complex tasks. Constraint from ELINOR's operational facilities was felt by all learning style groups in all tasks with the exception of Pragmatists who experienced no constraint in Tasks 1 or 2.

The patterns of information retrieval and attitudes associated with characteristics other than learning style were analysed to assess their influence on the research outcome. The patterns and attitudes observed were similar to those for learning style indicating that the research outcome was not influenced by individual differences in other characteristics. However, this finding also indicates a possible influence from a further factor not considered within this research.

Chapter 9, Discussion and Conclusions, restates the research objectives and provides an indication of how the findings may be used in enhancing the design of effective ELS, and their relevance to the field of information retrieval in general. Opportunities for further research are also highlighted.

# CHAPTER 9

## DISCUSSION AND CONCLUSIONS

Chapter 9 summarises the findings from the research reported in this thesis. The research objectives are reiterated in Section 9.1, whilst Section 9.2 briefly re-describes the methodology employed and its suitability in achieving the objectives. The conclusions from the research are provided in Section 9.3. Findings revealed that ELINOR's present functionality cannot support the information retrieval activities of each learning style group. Possible extensions to ELINOR's functionality are described in Section 9.4. Section 9.5 indicates how the findings may be applied more widely. Finally, Section 9.6 identifies opportunities for further research.

### 9.1 Research Objectives

Electronic information retrieval is becoming increasingly employed within higher education institutions as a result of its cost effectiveness and ability to manage large quantities of information. Storage and retrieval of information via Electronic Library Systems (ELS) overcome many problems associated with other methods of information retrieval. For example, ELS provide the ability to store the full-text of documents whereas many systems provide only bibliographic information. Problems of storage space are overcome as the need to store physical documents is eliminated. The document content of ELS can also be adapted to meet the needs of individual institutions. Use of a network provides the ability to access ELS simultaneously from multiple locations, thus reducing problems associated with document availability and the expense of inter-library loans.

It is desirable that information retrieval systems, including ELS, are effective in meeting the needs and preferences of target users. In order to design effective systems an insight into the influence of individual differences on information retrieval behaviour and attitudes is required. An understanding of differences in cognitive and learning processes, including learning style, is considered highly relevant to the design of information systems (Shneiderman, 1987: Bariff and Lusk, 1977; De Diana et al., 1994). Therefore, exploration of the influence of learning style on the use of, and attitudes towards, ELS is a particularly significant area for research.

Previous research regarding the influence of learning style on information retrieval has not focused specifically on ELS. Research undertaken using other information retrieval systems, such as CD ROM (Balaraman, 1991) and on-line databases (Saracevic et al., 1988) reveals little of substance on which to build research within the ELS environment. This inadequacy arises from inconsistencies in the research objectives and methodologies employed. However, research undertaken using Hypertext/Hypermedia systems (Ellis, Ford and Wood, 1993; Liu and Reed, 1994 and; Leader and Klein, 1994) supports the view that learning style requires consideration in the design of information retrieval systems.

The research described in this thesis provides the foundation on which to build further understanding of the influence of learning style, and other characteristics, on information retrieval from ELS. The methodology employed is considered to be highly appropriate for the investigation, allowing sufficient data to be gathered for answering the research questions. Employing similar research methods in exploring the relationship between individual characteristics and information retrieval from other ELS will facilitate comparison between findings. Thus meaningful conclusions may be drawn regarding the functionality necessary for the effective design of all ELS.

The research described in this thesis explores the relationship between learning style and information retrieval from ELINOR (an example ELS) over a range of tasks. The first question which the research addresses is as follows.

> *Does learning style influence patterns of information retrieval from ELINOR for simple and complex tasks?*

It was expected that learning style would influence patterns of information retrieval for complex tasks, but not simple tasks. Simple tasks are somewhat prescribed in nature and require participants to find specific items contained within ELINOR.

Patterns of information retrieval refer to the actions performed in the process of searching for information rather than the outcome achieved (Section 5.4). Information regarding the patterns of information retrieval adopted by each learning style group is considered to be of greater value to the design of effective ELS than outcome measures, such as precision and recall.

The research also considers the ability of ELINOR to support the information retrieval activities of different learning style groups over a range of tasks. This was assessed in terms of attitudes towards the number and nature of documents and operational facilities contained within ELINOR. The second question which the research addresses is as follows.

> *Can ELINOR's functionality support the information retrieval activities of different learning style groups for simple and complex tasks?*

It was expected that ELINOR would provide the required functionality, in terms of both document content and operational facilities, to support the information retrieval activities of all learning style groups when performing simple tasks. For complex tasks, it was expected that each learning style group would find ELINOR's operational facilities to be adequate but would be constrained by ELINOR's limited document content.

## 9.2 Methodology

The methodology employed within this research is considered to be highly appropriate for the investigation, allowing sufficient data to be gathered for answering the research questions. Hypotheses were developed and investigated by examining relevant summaries of data and confidence intervals. A logging system (described in Section 6.8.1) was employed in gathering statistical data regarding the number and nature of documents and operational facilities used by students undertaking tasks using ELINOR. Questionnaires were employed in ascertaining the learning styles (Section 6.3), demographic characteristics (Section 6.4.2) and attitudes of students towards ELINOR's functionality (Section 6.8.2). Interviews (Section 6.8.3) were used in collecting qualitative data to aid interpretation of responses to the evaluation questionnaire and validate the research methodology.

### 9.2.1 Target Population

The target population comprised students undertaking computing courses at De Montfort University's Leicester campus. At the time the research was undertaken, computing texts comprised one of the largest subject areas within ELINOR. Thus, computing students provided the most appropriate target population (Section 6.2). The choice of target population also prevented individual differences associated with academic discipline, topic knowledge and previous experience of ELINOR influencing the research outcome.

### 9.2.2 Identifying Learning Style

The LSQ provided an instrument for identifying the learning styles of the target population. It is quick and easy to administer and requires no expert knowledge in its scoring or interpretation. It is also a self-report inventory which allows completion by large groups of students at the same time. This was advantageous as it was administered during lecture time. The LSQ is considered to show sufficient validity and reliability for the purposes of this research (Section 5.3).

### 9.2.3 Characteristics Other Than Learning Style

Measures were taken to prevent individual differences in characteristics other than learning style influencing the research outcome (Section 6.4). However, differences in gender, ethnic origin, social class, computer affinity, computer literacy and search experience could not be minimised without significantly reducing the sample size available (Section 6.5). Analysis was undertaken to assess the influence of these characteristics on the research outcome (Section 8.3).

### 9.2.4 Selection Of A Research Sample

Only students with a strong or very strong preference for one learning style were included within the research sample. This provided the maximum distinction between learning style preferences, allowing the information retrieval patterns and attitudes towards ELINOR's functionality associated with each style to be more easily assessed (Section 6.5). The sample comprised 19 Activists, 16 Reflectors, 12 Theorists and 6 Pragmatists (Section 6.5).

### 9.2.5 Training

A training programme was provided for all students to complete prior to the tasks. This ensured that students held similar levels of experience in using ELINOR and were familiar with the functionality necessary for performing the tasks. Where ELINOR provides alternative facilities for performing operations, an explanation of each facility was given in the training programme. As data regarding the information retrieval patterns associated with different learning styles was required, it was necessary to allow students choice in the method by which they completed the tasks (Section 6.6).

### 9.2.6 Tasks

The tasks were based on the content of the courses being undertaken by the students. This provided interest and an opportunity to gain knowledge beneficial to their studies. Both simple and complex tasks were provided in order to assess the influence of learning style on information retrieval and ELINOR's ability to support information retrieval over a range of activities (Section 6.7).

### 9.2.7 Data Collection

Data regarding the number and nature of both documents and operational facilities used in each task was provided by a logging system (Section 6.8.1). The attitudes of students regarding the extent to which they were constrained by ELINOR's functionality were recorded by an evaluation questionnaire (Section 6.8.2). Careful consideration was given to the design of the questionnaire, and approval gained from a qualified statistician. However, a number of students repeatedly misunderstood the requirements for responding to Question 3. Question 3 asked students to indicate their preferences regarding the number and nature of documents contained within ELINOR. Students continued to misinterpret the question, despite two alterations of the questionnaire design and verbal explanation of the requirements for response. Therefore, conclusions regarding students' preferences towards ELINOR's document content must be interpreted with care. Interviews were conducted to gain an insight into the attitudes of students regarding the research experience (Section 6.8.3). A positive response was gained providing further evidence that the research methodology is appropriate for the investigation. The interviews also aided interpretation of responses to the evaluation questionnaire.

## 9.3 Conclusions

Findings from this research suggest there is little influence of learning style on patterns of information retrieval from ELINOR. No indication of a relationship was found between learning style and the number and nature of documents or operational facilities used for Task 1. Confidence intervals showed a difference between Activists and Pragmatists in the number of documents used in Task 2 and the number and nature of operational facilities used in Task 3. However, as there were only 6 Pragmatists within the sample, this finding is not conclusive. Regarding the Search and Fileroom facilities, all learning style groups preferred to use the Search facility in Tasks 1 and 3. The Search facility operates in a similar way to the OPAC, database and CD ROM facilities available to students within De Montfort University. Existing experience of these facilities may have influenced the way in which students approached searches within ELINOR. However, analysis revealed that this was not the case. A possible relationship between learning style and use of the Search and Fileroom facilities was found for Task 2. For this task, Activists made greater use of the Search facility, whilst Theorists and Reflectors preferred the Fileroom, although this preference was not well marked. The findings suggest that all learning style groups require facilities for searching ELINOR's document content by the use of clue words, the results of each search being reported in a hit list. However, facilities which provide an overview of the entire document content are also beneficial to Reflectors and Theorists.

The ability of ELINOR's functionality to support the information retrieval activities of different learning style groups was also considered. Analysis indicates that the number and nature of documents within ELINOR are insufficient for successful completion of both simple and complex tasks by all learning style groups. This finding is surprising given that the simple tasks required students to find specific documents within ELINOR. However, in completing the evaluation questionnaire, a number of participants omitted to relate their answers to the task, and responses reflected more general attitudes towards ELINOR's document content. Therefore, conclusions regarding the extent to which students were constrained by the document content must remain tentative. All learning style groups were constrained by ELINOR's operational facilities in each task with the exception of Pragmatists who experienced no constraint in Tasks 1 or 2. The type of facilities required to support information retrieval by each learning style group were described in Section 8.2.1.

The analysis of information retrieval patterns was repeated for the sample when categorised by gender, ethnic origin, social class, computer affinity, computer literacy and search experience. The ability of ELINOR to support the information retrieval activities associated with these characteristics was also explored. Findings suggest little influence of any of these characteristics on the number and nature of documents and operational facilities used. However, each group associated with the aforementioned characteristics made greater use of the Search facility in Tasks 1 and 3. For Task 2, the majority of groups had an approximately equal preference for both facilities. The attitudes of students towards ELINOR's functionality revealed that ELINOR cannot support the information retrieval activities associated with any of the aforementioned characteristics.

Similarities are apparent between the findings for learning style and other characteristics. This suggests that the research outcome was not biased from the influence of characteristics other than learning style. However, the similarity in findings also suggests there may be a further characteristic influencing information retrieval patterns and attitudes other than those included within this research. Differences within a number of characteristics were eliminated in order to ensure their influence did not bias the research findings. As such, the final sample showed consistency in characteristics including age, nationality and academic discipline. Therefore, the similarity in information retrieval patterns and attitudes may be a function of one or more of these factors. More research is required in order to explore these issues further (Section 9.6).

Section 7.1.3 explained that software defects are present within ELINOR. Analysis was undertaken to assess the extent to which these defects may influence the research outcome. System defects affected the number and nature of operational facilities used in Tasks 1 and 3 only. The use of operational facilities in Task 2 and documents remained unaffected. The research outcome was not influenced by system defects in any instance.

When the sample was categorised by demographic characteristics, a number of groups comprised few members. These groups did not provide enough data with which to perform an analysis of the information retrieval patterns associated with them or the extent to which they were constrained by ELINOR's functionality. Two methods of treating the data for these groups were reported (Section 8.3). Firstly, the groups may be excluded from the analysis.

Alternatively, the analysis may be performed when the groups are combined with other groups. Within this research, both methods were undertaken, allowing any influence from the treatment of the data to be assessed. No influence from differences in the treatment of groups was observed.

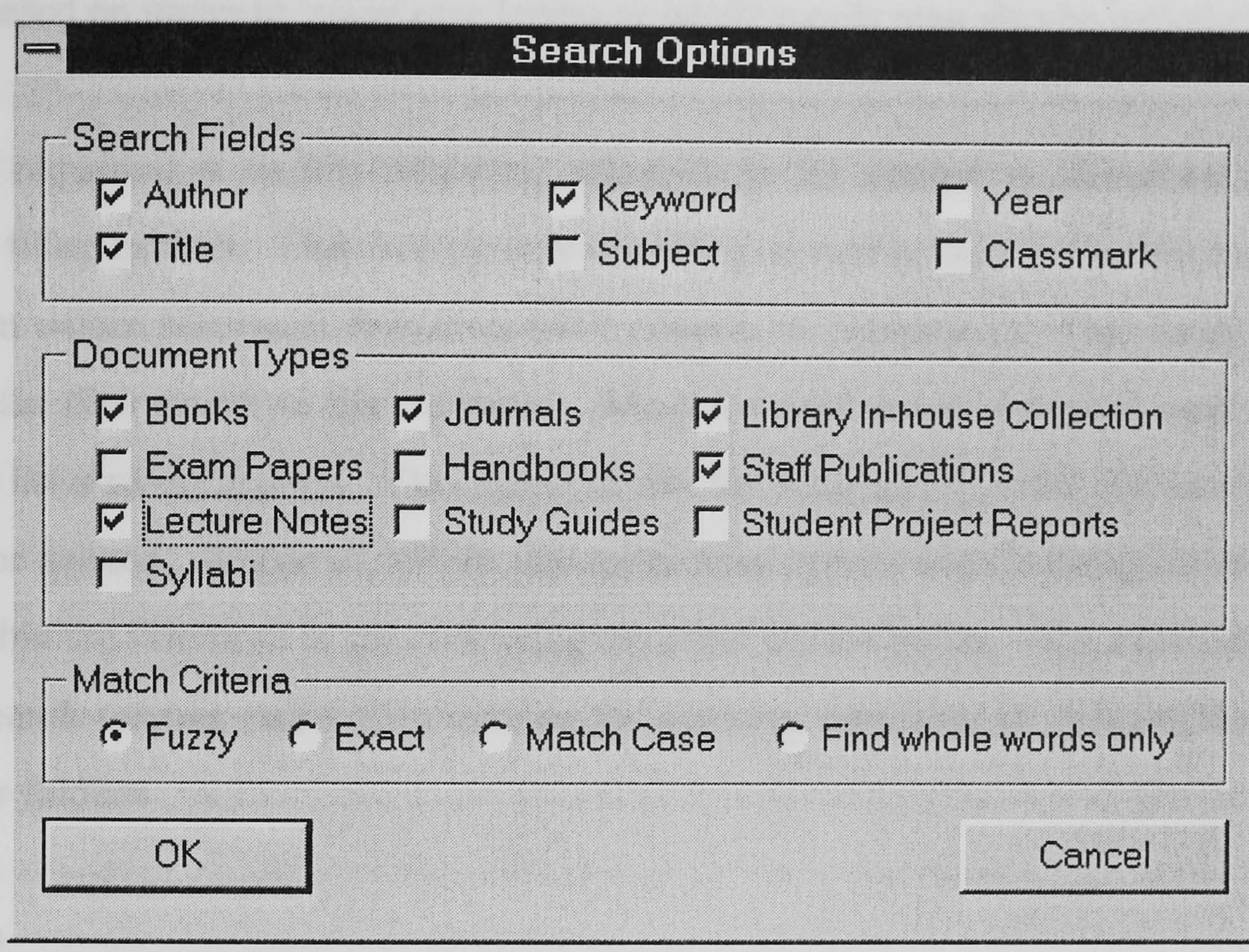
## 9.4 Possible Extensions To ELINOR's Functionality

The findings from this research reveal that ELINOR's present functionality cannot support the information retrieval activities of each learning style group and changes to the document content and operational facilities are necessary. A greater number of some document types are required to facilitate information retrieval by all learning style groups in all three tasks. A lesser number of other document types are necessary to facilitate the activities of Activists, Reflectors and Theorists in all tasks and Pragmatists in Tasks 2 and 3. However, this conclusion is tentative as a number of students failed to provide the information necessary for analysis. Greater detail regarding the preferences of students towards ELINOR's document content is contained in Appendix M.

Students requested additional operational facilities to help them complete the tasks. These were described in Section 8.2.1. The characteristics of a number of these facilities were obvious from the descriptions provided by the students. For example, the provision of buttons rather than menus and; an option allowing the contents page of a document to be viewed at the touch of a button. The characteristics of other facilities were not obvious. The following paragraphs describe possible extensions to ELINOR's functionality in order to provide these facilities.

Activists and Reflectors requested a facility which allows certain types of document to be excluded from a search. Reflectors and Theorists requested a facility allowing users to perform single or multiple searches using bibliographic information as the search criteria. In order to provide this functionality, a dialog box providing various options for limiting the search may be incorporated within ELINOR's Search Window. A possible design for the dialog box is illustrated in Figure 9.1.

Figure 9.1
A Possible Design For A Search Options Dialog Box

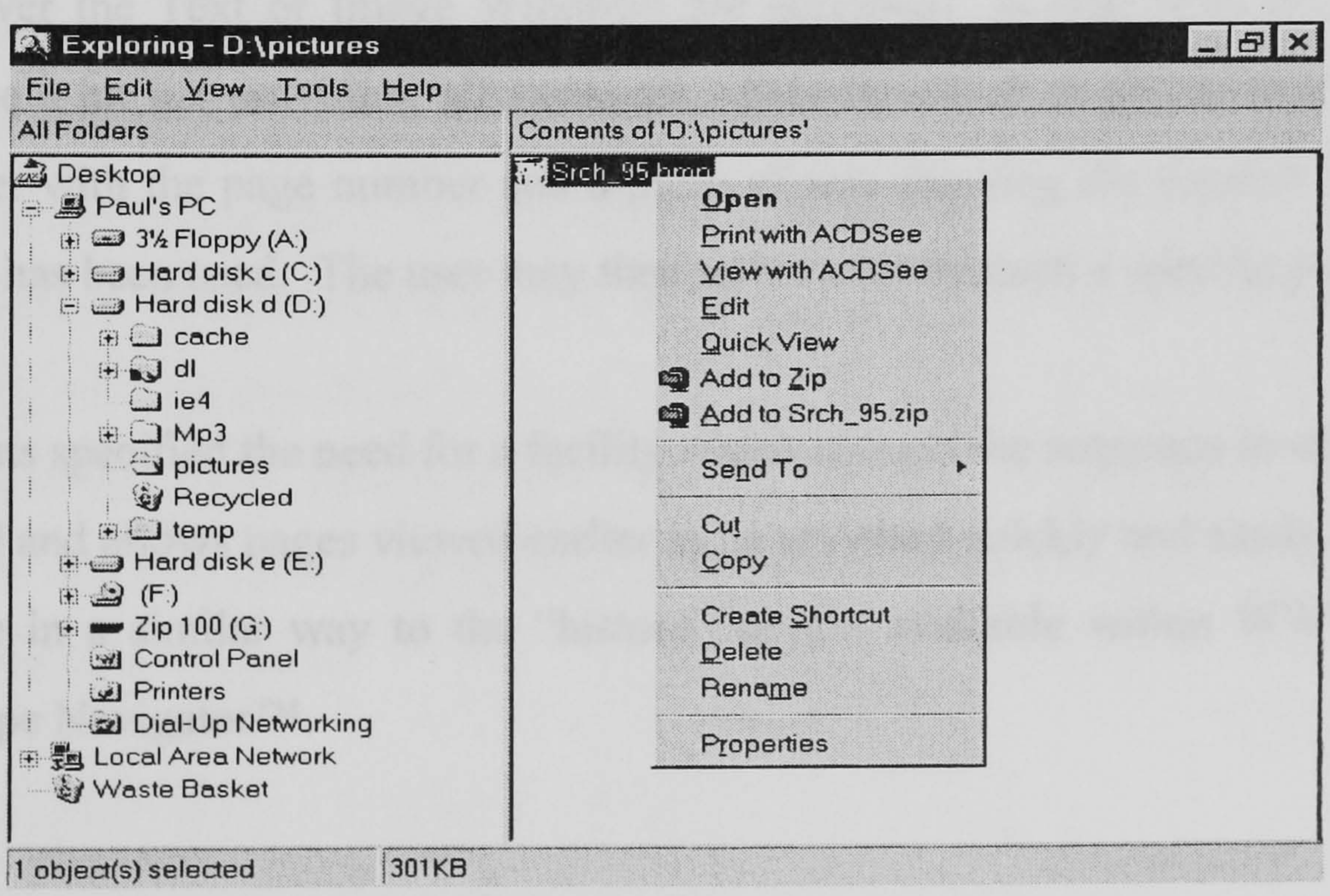



The dialog box provides a list of fields relating to the different document types contained within ELINOR and various bibliographic information. The search may be limited to one or more document types and/or one or more bibliographic fields by selecting the various check boxes provided. Within Figure 9.1 a tick indicates which documents types and bibliographic fields have been selected. The dialog box may be accessed by use of a button or menu and must be completed before a search is conducted. A facility for adjusting the degree to which the search matches the clue words entered may also be included within the search options dialog box. This is indicated in Figure 9.1 by the words "Match Criteria". ELINOR's present functionality includes a fuzzy searching technique which retrieves hits containing both exact matches and similar matches to the clue words entered (Section 2.3.3). However, the ability to include only exact matches to the clue words entered within the hit list was requested by

Reflectors. ELINOR provides a facility for rating the hit list (Section 2.3.3) Thus, hits which bear an exact match to the clue words entered will appear at the top of the list. However, a facility which allows the user to choose between fuzzy searching and exact searching may be of benefit to those who wish to reduce the hit list further. Within Figure 9.1 the option for using a fuzzy searching technique is selected. Options for limiting the search to include only matches based on upper or lower case letters or whole words may also be included.

Theorists requested a facility allowing searches to be limited to documents within one particular filing cabinet. This facility may operate in a similar way to the Microsoft Explorer application within Microsoft Windows 95™ (shown in Figure 9.2). This facility provides a list of all the files stored on the computer. When the right mouse button is used to select any file in the list a menu appears. This menu allows the selected file to be, for example, opened, renamed or deleted. Within ELINOR, this menu may appear when a filing cabinet, drawer or folder within the Fileroom is selected using the right mouse button. The menu would provide various search options rather than options for opening, renaming or deleting filing cabinets, drawers or folders.

Figure 9.2
An Illustration Of The Microsoft Explorer Application



Activists and Reflectors specified the need for a facility allowing bibliographic information for individual documents to be found quickly and easily. Although ELINOR provides this functionality through the Document Control facility (Section 2.3.4), it does not contain information for each document. The findings from this research have shown that this facility is required in order for students to supply references for the information within ELINOR. Therefore, improving this facility to include information for all the documents contained within ELINOR is necessary. Task 1 required students to find the author of the document entitled "Expert Systems: Tools and Applications" (Section 6.7). Theorists requested the ability to find out what type of document this was. A facility providing bibliographic information would also help in this respect.

Reflectors requested a facility for searching within documents. Such a facility could operate in a similar way to the "find" option currently available within packages such as Microsoft's Word for Windows™. The facility would allow the whole document or sections of the document to be searched for instances where specified words or phrases appear. For example, students may wish to search for the word "prototyping". Once the word or phrase is found, the student may choose to view the next instance in which it appears or go back and view the previous instance. Alternatively, an option may be included which operates in a similar way to the Search Window currently provided by ELINOR. This facility would be available whenever the Text or Image Windows are accessed. A clue word or phrase is entered to produce a hit list providing all instances where the word or phrase appears in the document together with the page number and a piece of text showing the context in which the word or phrase has been used. The user may then select a hit to reach a specific page.

Activists specified the need for a facility which records the sequence in which pages have been viewed and allows pages viewed earlier to be revisited quickly and easily. Such a facility may operate in a similar way to the "history" option available within WWW browsers such as Netscape Navigator™.

Theorists requested a facility providing links from the contents pages of documents to the corresponding pages within the document. This would be possible through the use of Hypertext. Hypertext was defined in Section 4.1.

Facilities for searching using Boolean operators and for viewing multiple documents simultaneously were also requested by Pragmatists and Activists, respectively. ELINOR currently provides this functionality (Section 2.3.3 and 2.3.5). However, it was not described within the training programme. Therefore, students may not have realised this functionality exists unless they took time to explore ELINOR.

## 9.5 The Applicability Of The Research Findings To Other Areas Of Information Retrieval

The findings from this research prescribe the functionality necessary for ELINOR to support the information retrieval activities of different learning style groups. However, this functionality may also enhance the effectiveness of any information retrieval system which comprises the full-text of documents, including ELS (other than ELINOR), CD ROM, Hypertext systems, and various Internet resources. The majority of these systems employ search techniques similar to ELINOR's Search facility whereby the text within documents is matched to a query supplied by the user (Section 5.2). However, the findings from this research have shown that, for some simple tasks, Theorists and Reflectors may also require facilities providing a more global approach to information gathering. For systems which do not have this functionality, the addition of such facilities will be of benefit in enhancing their effectiveness. Within ELINOR, the Fileroom provides a global approach to information gathering through the ability to browse the entire content of the system through a hierarchy relating to subject or document type. The finding that different learning style groups require facilities allowing detailed specification of information needs to gain precision in searching is important to all systems.

Students requested a number of other facilities which may enhance the effectiveness of information retrieval systems other than ELINOR. These include facilities for: performing operations by the use of buttons rather than menus; finding bibliographic information; viewing documents simultaneously; recording the sequence in which pages have been viewed and; linking contents pages to corresponding pages within the document.

The research described in this thesis considers the influence of gender, ethnic origin, social class, computer affinity, computer literacy and search experience on information retrieval from ELINOR. ELINOR's ability to facilitate the information retrieval activities associated with these characteristics is also explored. These issues were primarily examined to ensure the research outcome was not influenced by differences in characteristics other than learning style. However, the conclusions will also aid in designing effective information retrieval systems.

### 9.6 Opportunities For Further Research

The sample used in this research comprised few Theorists and Pragmatists. Therefore, the ability to make inferences regarding the patterns of information retrieval associated with these groups and their requirements regarding ELINOR's functionality is limited. Further research, using larger numbers of Theorists and Pragmatists, will be of benefit in this respect.

The LSQ was employed in measuring learning style preferences. The learning styles identified by the LSQ are described as Activist, Pragmatist, Theorist and Reflector. Section 3.2.5 explained that the LSQ not only identifies an individual's preferred learning style, but also the strength of that preference which may be either very strong, strong, moderate, low or very low. The LSQ also identifies instances where respondents have an equal preference for more than one learning style. Only students with a strong or very strong preference for one learning style were included within this research. Section 6.5 explained that students with moderate, low or very low preferences for one learning style may adopt different information retrieval patterns and/or attitudes regarding functionality from those with a strong or very strong preference for the same style. Section 6.5 also explained that those with an equal preference for more than one learning style may adopt information retrieval patterns and/or attitudes which are different from those associated with individual styles. Data regarding the information retrieval patterns and attitudes associated with all learning style preferences will further aid the design of ELS.

Learning style instruments, other than the LSQ, may measure different aspects of learning style. Section 3.3 explained that a number of learning style instruments identify styles which bear similarity with those identified by the LSQ. However, it cannot be assumed that the information retrieval patterns associated with similar styles will be the same as those observed within this research. Neither can it be assumed that the requirements associated with similar styles regarding the number and nature of documents and operational facilities will be the same as those reported in the research findings. Repeating the investigation using alternative instruments will provide an insight into the relationship between information retrieval and aspects of learning style not considered within this research. It will also provide insight into the functionality required to support information retrieval by other learning style groups. This will aid the design of ELS which are effective in meeting the requirements of a wider range of styles than those considered within this research.

Some ELS may provide functionality which supports the information retrieval activities of different learning style groups to a greater extent than other ELS. Research regarding the attitudes held by different learning style groups towards a variety of ELS will indicate the functionality which provides the greatest support. The functionality from a number of systems may be combined within one system to produce an ELS which is highly effective.

Section 9.5 stated that the findings from this research may be used in ensuring the effectiveness of a wide variety of information retrieval systems. However, it cannot be assumed that the findings will also assist in the design of information retrieval systems based on criteria other than the full-text of documents. User requirements regarding functionality may not be consistent for different types of system (Section 5.1). Further research is needed in order to establish the extent to which user requirements for different systems are similar. If similarities are found then the research described in this thesis will aid in the design of systems based on a variety of media. If the requirements are different, then further research will provide an indication of the functionality needed to enhance the effectiveness of systems based on criteria other than the full-text of documents.

Laurillard (1979) argues that learning styles are dependent on the context or environment in which learning takes place (Section 5.5). The context within which the present research took place was consistent for all participants. If Laurillard's argument is valid, this may account for the similarity in patterns of information retrieval observed among the learning style groups, assuming learning style influences information retrieval patterns. An opportunity for further research lies in repeating the investigation within different contexts, or learning environments. Laurillard (1979) suggests that learning style is dependent on the nature of the subject matter. Therefore, requiring participants to undertake a variety of tasks based on differing topics may reveal differences in patterns of information retrieval. However, the possibility of bias from differences in topic knowledge must be considered when undertaking such research. Laurillard also suggests that learning style may be dependent on whether a deep understanding of the subject matter is required, or simply the ability to reproduce information. If a relationship between learning style and information retrieval exists, the information retrieval patterns observed within the present research may have been prescribed by the need to gather information only. If the investigation were to require deeper understanding of the subject matter, a different outcome may be observed. Such a context could be achieved by employing methods such as "teachback" (Ellis, Ford and Wood, 1993) in which students are required to demonstrate their understanding of the subject matter.

Measures were taken to ensure that differences in characteristics, other than learning style, did not influence the research outcome. Consistency within characteristics such as age, nationality and academic discipline was maintained across the student population. The observed similarities in the information retrieval patterns among the user groups may be the result of similarities in one or more of these characteristics. Therefore, further research regarding the patterns associated with these characteristics would be beneficial. Research regarding the relationship between information retrieval and differences in characteristics not considered within this research, for example aspects of personality other than learning style, would indicate whether they need consideration when designing systems. Conclusions regarding the number and nature of documents and operational facilities required to support the information retrieval activities associated with different characteristics would prescribe the functionality necessary to support the information retrieval activities associated with a wider range of individual differences than those considered within this research.

A number of hypotheses have been identified for undertaking further research. These are as follows.

> *The information retrieval patterns associated with different learning styles vary according to the strength of the learning style preference which may be either very strong, strong, moderate, low or very low.*
>
> *The requirements associated with different learning styles regarding functionality vary according to the strength of the learning style preference which may be either very strong, strong, moderate, low or very low.*
>
> *The information retrieval patterns adopted by individuals vary according to the number of learning styles for which they have an equal preference.*
>
> *The requirements associated with different learning styles regarding functionality vary according to the number of learning styles for which individuals have an equal preference.*
>
> *The information retrieval patterns associated with the learning styles identified by the LSQ differ from those associated with styles identified by other instruments.*
>
> *The functionality required to support the information retrieval activities associated with the learning styles identified by the LSQ differs from that required to support the activities associated with styles identified by other instruments.*

*The functionality required to support information retrieval from ELINOR also supports information retrieval from systems whose content comprises media other than text.*

*Patterns of information retrieval will differ according to the context in which learning takes place.*

*The requirements of individuals regarding functionality will differ according to the context in which learning takes place.*

*Similar information retrieval patterns occur amongst users of similar age, nationality and academic discipline, whereas differences in information retrieval patterns occur amongst users of differing age, nationality and academic discipline.*

*Similar requirements regarding functionality occur amongst users of similar age, nationality and academic discipline, whereas different requirements occur amongst users of differing age, nationality and academic discipline.*

**Summary**

Chapter 9 discussed the research findings and their implications regarding the design of effective ELS. The research objectives were re-stated (Section 9.1) and the methodology re-described in Section 9.2. The research uses ELINOR (an example ELS) in researching the influence of learning style on information retrieval from ELS and; the functionality required for ELS to support the information retrieval activities associated with different learning style groups. ELINOR's content comprises the full-text of documents. Therefore, the outcomes from this research may not be applicable to ELS whose content is based on, for example, photographs. However, a major aim of all ELS is to reduce the need for libraries to store physical documents. As the majority of documents academic libraries are required to hold are text-based, the majority of ELS developed are also likely to be text-based. Therefore, use of ELINOR, as an example ELS is highly appropriate within this research (Section 5.2).

Only respondents with a strong or very strong preference for one particular learning style participated in the research. This provided the maximum distinction between learning style preferences, allowing the information retrieval patterns and attitudes towards ELINOR's functionality associated with each style to be more easily assessed (Section 6.5). However, conclusions (described in Section 9.3) suggested little evidence of a relationship between learning style and patterns of information retrieval from ELINOR despite the clearly defined learning style preferences of the research sample. An exception to this finding occurred when considering the relationship between learning style and use of the Search and Fileroom facilities. Analysis revealed that for Task 2 Activists preferred to use the Search facility whilst Theorists and Reflectors preferred the Fileroom. This outcome is consistent with the findings of research by Ellis, Ford and Wood (1993), Liu and Reed (1994) and Leader and Klein (1994) (reviewed in Section 4.1) in which a relationship between learning style and use of facilities within Hypertext learning packages, similar to the Search and Fileroom, was observed. However, although a relationship seems likely, more research is needed in order to confirm that learning style requires consideration when designing ELS.

Findings also revealed that changes to both ELINOR's document content and operational facilities are required for the system to support the information retrieval activities of all learning style groups. Possible extensions to ELINOR's functionality were discussed in Section 9.4. The operational facilities most frequently requested by each learning style group were: facilities allowing greater precision in searching; the ability to find bibliographic information quickly and easily and; the provision of buttons rather than menus for performing operations. There were no clearly defined differences in the preferences of each learning style group regarding the nature of additional facilities requested.

Section 9.5 explained that many information retrieval systems incorporate similar functionality to that employed by ELINOR. Thus, the functionality required for ELINOR to be effective in supporting the information retrieval activities of different learning style groups may also be applied in enhancing the effectiveness of any information retrieval system which comprises the full-text of documents.

Finally, some opportunities for further research were highlighted and hypotheses proposed (Section 9.6). Further research will provide insight into the relationship between a wide variety of characteristics and information retrieval from ELS. It will also prescribe the functionality required for ELS to support the information retrieval activities of different user groups. This is important if ELS are to be effective in meeting the needs and preferences of target users. The research described in this thesis provides the foundation on which to build this research.

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# APPENDIX A

## Examples Of Electronic Library Projects

## A.1 Examples Of Electronic Library Projects

This appendix briefly describes examples of electronic library projects. Descriptions for the majority of projects have been based on information given in Ramsden et al. (1994) and the eLib web site (http://www.ukoln.ac.uk/services/elib/). Details of the Decomate project have been taken from the project's web site (http://www.lse.ac.uk/decomate/). Details of the Heron project have been taken from a press release submitted to the lis-elib email discussion list.

ELISE (Electronic Library Image Service for Europe)

ELISE was developed by De Montfort University in partnership with the IBM UK Scientific Centre, the Victoria and Albert Museum (V&A) and Tilburg University in the Netherlands. The aim of ELISE is to provide access to colour images held in libraries in the European Union. The images comprise collections held by the V&A and manuscripts and charts relating to the Brabant areas of the Netherlands, held by Tilburg University.

MusicalScores Multimedia Prototype

MusicalScores is a joint venture between Case Western Reserve University and the IBM Corporation. It evaluates digital imaging and multimedia technologies for presentation of instructional and research materials. The aim of one prototype system is to develop an easy-to-use instructional tool for students on the History of Western Music course. Other prototypes include presentation of radiographic materials, an electronic version of medical and engineering textbooks and an electronic art gallery application.

Red Sage: University of California, San Francisco

The Red Sage project uses an electronic journal system developed by AT&T Bell laboratories, known as RightPages. The user interface displays an array of periodical covers on the screen, similar to the display of periodicals in a library. The user follows a hierarchical route through the database, starting the process by pointing and clicking on a cover to view the issues. After selecting an issue, the table of contents is displayed. From the contents page, users can click on the article entry to view the full-text of the article. Journal issues can also be browsed page by page and articles printed on demand.

Mercury Electronic Library: Carnegie Mellon University

The objective of this project is to build an electronic library which delivers a large percentage of the information used in a specific discipline to the desks of people doing research in that discipline. The information contained within the computer system includes journals from the Association for Computing Machinery, the Institute of Electrical and Electronic Engineers, and the American Association for Artificial Intelligence. The Mercury project focuses on the full-text of documents including graphics.

CORE (Chemistry On-line Retrieval Experiment): Cornell University

The CORE project focuses on creating a useful, usable electronic library which is accessible to the 100 faculty and postgraduate chemistry researchers via the high-speed campus network. The project goals are: firstly, to assess the effectiveness and acceptability of electronic access to journal articles as compared with printed forms, and; to identify which functions of the user interface to an electronic journal system are most desirable.

ELSA (Electronic Library SGML Applications): De Montfort University

The aim of the ELSA project is to develop a prototype system for handling electronically published documents. The system imports full-text journal articles in SGML format supplied by the Reed Elsevier Science publishers group. SGML refers to Standardised Generalised Markup Language. SGML assists in the creation, management, storage and delivery of documents by assigning a set of codes according the role and logical relationships between elements, e.g. chapter headings, figure reference, and subheadings. Although documents delivered electronically are unable to retain the original format, the codes allow the end-user to understand where the headings and figures etc. lie.

EEVL: Edinburgh Engineering Virtual Library

The EEVL project provides a central access point to networked Engineering information. The EEVL Gateway is a World Wide Web interface consisting of a Main Database of Engineering Resources, and other related services. The Main Database is a catalogue of Engineering information resources available on the Internet. It provides a central access point to networked Engineering information for the UK higher education and research community and for engineers generally. Resources added to the EEVL database are selected, catalogued and classified by experts to ensure that only current, high-quality resources are included. As well as providing access to current resources EEVL encourages the creation and provision of new Engineering resources. An important part of the project is to disseminate and promote awareness of the Gateway amongst UK higher education institutions.

Internet Library of Early Journals (ILEJ)

ILEJ is a joint project by the Universities of Birmingham, Leeds, Manchester and Oxford. It aims to digitise substantial runs of 18th and 19th century journals, and make these images available on the Internet. The project aims to gather information regarding who uses the service, how frequently and for what purposes. Information will also be sought regarding the acceptability of images and indexes to users. The intended outcome is firm evidence and recommendations on the technological, economic and user acceptability aspects of digitisation which could serve as a basis for the development of a national digitisation programme for out-of-copyright journals.

InfoBike

The Infobike project is devised and led by Bath Information Data Services (BIDS) at Bath University. InfoBike will provide the ability for users to search for articles of interest within bibliographic databases, to order articles in an electronic form and have them delivered to the user's work station for browsing. The key features of the project are:

- Document ordering facilities through the Infobike Gateway (or via BIDS).
- World Wide Web access to publisher's catalogues and document delivery to the Web browser. (Publishers catalogues will contain header information describing each document in the electronic document store).
- Web access to fill-in forms allowing users to enter themselves the biographical details of the document they wish to order.
- Electronic Journals, initially in Adobe Acrobat PDF format and later with full multimedia material, on local or remote document servers.
- Transaction management which supports both journal licensing arrangements, and payment systems. The licensing arrangements between publishers and institutions may allow free access at the point of use.

Sociological Research On-line

Sociological Research On-line is an electronic journal published jointly by the Universities of Surrey and Stirling, Sage Publications Ltd. and the British Sociological Association. Sociological Research On-line publishes electronically a wide range of high quality applied sociological articles, focusing on theoretical, empirical and methodological discussions which engage with current political, cultural and intellectual topics and debates. Articles are available for reading over the Internet. As well as publishing articles, the journal stimulates debates and publishes book and software reviews and research resources. The potential advantages of an electronic journal over its traditional counterpart include faster times to publication, increased speed of editorial processes, cheaper production costs and low distribution costs.

ACORN: Access to COurse Readings via Networks

ACORN is a partnership between Loughborough University, Swets & Zeitlinger BV, and Leicester University Library. Project ACORN has explored the potential of IT to deliver high-demand material electronically to students, across the campus, via networked computers. It has also developed and implemented a model for effectively managing the whole process, from requesting reading lists from academic staff to the consultation of the text by students. An electronic copyright management system has been developed. The project has also reported on the procedures required for gaining electronic copyright permissions. It has undertaken a number of evaluation activities including a survey of short loan collection users; a survey of academic staff attitudes to reading lists and short loan collections; a questionnaire survey and focus group discussions on the electronic system and; an assessment of the role of an intermediary in copyright clearance and digitisation.

MIDRIB: Medical Images: Digitised Reference Information Bank

MIDRIB is located at St George's Hospital Medical School, London and benefits from input from the Wellcome Trust and OMNI (Organising Medical Networked Information). MIDRIB will create, maintain and deliver a comprehensive collection of medical images in digital form. These will be for use in teaching and research, in medical and healthcare faculties of Universities and teaching hospitals. The project will draw together the best of existing collections into a coherent resource within a single point of reference. A number of collections, covering a large proportion of medical and allied disciplines, have already been identified at participating and other sites.

As the project matures, the resource will become the natural repository for collections of images, produced by individuals and departments throughout the higher education sector. This will be accessible from a single World Wide Web site via the SuperJanet higher education network. Images will also be made available on CD ROM.

HERON: Higher Education Resources ON-demand

The HERON project aims to develop an electronic resource bank of copyright-cleared material to support teaching and learning in higher education. The project will use the combined technical, marketing and project management skills of the University of Stirling, Napier University, South Bank University, Blackwell's Information Services and Blackwell Retail Ltd.

HERON will invite higher education institutions (HEIs) to become subscribing members. They will then be able to request material relevant to their courses from the HERON resource bank and obtain copyright clearance. They will also be able to request digitisation of new material. Member HEIs will also be able to deposit electronic materials belonging to them for wider use, and they will receive royalties in return. All HEIs will be entitled to use materials in the resource bank, on payment of relevant usage charges.

Distribution of materials will be by a variety of means. Some institutions will provide local electronic storage for the material of interest to them, arranging for students to print what they require or making arrangements centrally, for example through a bookshop, for printing and sale. Others will prefer a bookshop to handle the whole distribution process. An important feature, whatever the distribution mechanism, will be control, so that rights-owners can be properly recompensed.

Education-line: Electronic Texts in Education and Training

The Education-line project is managed on behalf of the University of Leeds Library by the British Education Index (BEI) at the University of Leeds. The objectives of Education-line are: to establish a generally accessible database of texts awaiting "traditional" publication or without widespread availability, making research results more quickly available; to facilitate discussion about such documents and general education and training issues and; to provide a wide community of users with an information resource which promotes quality research and practice.

The database will present electronic documents submitted by individual authors or research bodies. Documents will be indexed according to their content (subject matter) and type (research note, comment, conference paper, etc.) using a thesaural vocabulary. The search interface will allow searching by index terms via an on-line thesaurus as well as through free text.

Education-line is developing a live collection of documents on the Internet. It has been established so that researchers, practitioners and policy makers from the worlds of education and training can:

- present their work at early stages, for immediate review by colleagues world-wide
- store important documents for archiving
- publish specialised or small scale texts to the widest possible audience
- find the full-text of reports and papers relevant to their own interests, using the search tools of the British Education Index
- contribute to debates about the work through on-line commentary
- see the latest reports, as they appear, on a daily basis

DECOMATE II

The goal of DECOMATE II is to develop a service which provides access to information resources distributed over different libraries in Europe. The project will cover both heterogeneous materials (i.e. copyright and non-copyright materials of different types and formats) and distributed access (i.e. allowing users to access resources in any of the participating libraries though a single, uniform interface). The project will be based on the results of the successful DECOMATE I (completed in February 1997) which has resulted in a service providing end-user access, through individual libraries, to copyright materials distributed by publishers in electronic form. Special software has been developed which links bibliographic records to electronic full-text articles and allows the user to view documents or have them delivered in printed form. This software and the document distribution service has been made accessible to end-users within the participating academic institutions, both in the library and at the end-user's workplace through the campus network. The system includes a module for user-authorisation and usage monitoring and reporting, in order to enable solutions for the problems of copyright in the electronic library. User studies and dissemination activities form an important part of the project.

Decomate II will be a demonstrator and a test bed for license agreements with publishers and information providers, and for models of use of digital library services. Extensive user studies should develop new insights on user behaviour. Finally the Decomate II software will be tested in several European test sites to gain extensive knowledge on best practice and installation.

Expected benefits include better use of scientific electronic material in an educational environment through improved accessibility. Users will have access to a wide range of information resources available at various geographical locations and be able to choose between different levels of copyright and payment requirements.

The project partners developing DECOMATE II are Tilburg University Library, the British Library of Political & Economic Science and the Universitat Autònoma de Barcelona. Library Service.

# APPENDIX B

## The Learning Styles Questionnaire

Appendix B.1 contains a copy of the LSQ. Appendix B.2 describes the method used in scoring and interpreting responses to the LSQ. Appendix B.3 contains full descriptions of Honey and Mumford's four learning styles: Activist, Reflector, Theorist and Pragmatist.

## B.1 The Learning Styles Questionnaire

# LEARNING STYLES QUESTIONNAIRE

Revised 1986

This questionnaire is designed to find out your preferred learning style(s). Over the years you have probably developed learning 'habits' that help you benefit more from some experiences than from others. Since you are probably unaware of this, this questionnaire will help you pinpoint your learning preferences so that you are in a better position to select learning experiences that suit your style.

There is no time limit to this questionnaire. It will probably take you 10-15 minutes. The accuracy of the results depends on how honest you can be. There are no right or wrong answers. If you agree more than you disagree with a statement put a tick by it ( ✓ ). If you disagree more than you agree put a cross by it (✕). Be sure to mark each item with either a tick or cross.

☐ 1. I have strong beliefs about what is right and wrong, good and bad.

☐ 2. I often act without considering the possible consequences.

☐ 3. I tend to solve problems using a step-by-step approach.

☐ 4. I believe that formal procedures and policies restrict people.

☐ 5. I have a reputation for saying what I think, simply and directly.

☐ 6. I often find that actions based on feelings are as sound as those based on careful thought and analysis.

☐ 7. I like the sort of work where I have time for thorough preparation and implementation.

☐ 8. I regularly question people about their basic assumptions.

☐ 9. What matters most is whether something works in practice.

☐ 10. I actively seek out new experiences.

☐ 11. When I hear about a new idea or approach I immediately start working out how to apply it in practice.

☐ 12. I am keen on self discipline such as watching my diet, taking regular exercise, sticking to a fixed routine, etc.

☐ 13. I take pride in doing a thorough job.

☐ 14. I get on best with logical, analytical people and less well with spontaneous, 'irrational' people.

☐ 15. I take care over the interpretation of data available to me and avoid jumping to conclusions.

☐ 16. I like to reach a decision carefully after weighing up many alternatives.

☐ 17. I'm attracted more to novel, unusual ideas than to practical ones.

☐ 18. I don't like disorganised things and prefer to fit things into a coherent pattern.

☐ 19. I accept and stick to laid down procedures and policies so long as I regard them as an efficient way of getting the job done.

☐ 20. I like to relate my actions to a general principle.

☐ 21. In discussions I like to get straight to the point.

☐ 22. I tend to have distant, rather formal relationships with people at work.

☐ 23. I thrive on the challenge of tackling something new and different.

☐ 24. I enjoy fun-loving, spontaneous people.

☐ 25. I pay meticulous attention to detail before coming to a conclusion.

☐ 26. I find it difficult to produce ideas on impulse.

☐ 27. I believe in coming to the point immediately.

☐ 28. I am careful not to jump to conclusions too quickly.

☐ 29. I prefer to have as many sources of information as possible - the more data to think over the better.

☐ 30. Flippant people who don't take things seriously enough usually irritate me.

☐ 31. I listen to other people's points of view before putting my own forward.

☐ 32. I tend to be open about how I'm feeling.

☐ 33. In discussions I enjoy watching the manoeuvrings of the other participants.

☐ 34. I prefer to respond to events on a spontaneous, flexible basis rather than plan things out in advance.

☐ 35. I tend to be attracted to techniques such as network analysis, flow charts, branching programmes, contingency planning, etc.

☐ 36. It worries me if I have to rush out a piece of work to meet a tight deadline.

☐ 37. I tend to judge people's ideas on their practical merits.

☐ 38. Quiet, thoughtful people tend to make me feel uneasy.

☐ 39. I often get irritated by people who want to rush things.

☐ 40. It is more important to enjoy the present moment than to think about the past or future.

☐ 41. I think that decisions based on a thorough analysis of all the information are sounder than those based on intuition.

☐ 42. I tend to be a perfectionist.

☐ 43. In discussions I usually produce lots of spontaneous ideas.

☐ 44. In meetings I put forward practical realistic ideas.

☐ 45. More often than not, rules are there to be broken.

☐ 46. I prefer to stand back from a situation and consider all the perspectives.

☐ 47. I can often see inconsistencies and weaknesses in other people's arguments.

☐ 48. On balance I talk more than I listen.

☐ 49. I can often see better, more practical ways to get things done.

☐ 50. I think written reports should be short and to the point.

☐ 51. I believe that rational, logical thinking should win the day.

☐ 52. I tend to discuss specific things with people rather than engaging in social discussion.

☐ 53. I like people who approach things realistically rather than theoretically.

☐ 54. In discussions I get impatient with irrelevancies and digressions.

☐ 55. If I have a report to write I tend to produce lots of drafts before settling on the final version.

☐ 56. I am keen to try things out to see if they work in practice.

☐ 57. I am keen to reach answers via a logical approach.

☐ 58. I enjoy being the one that talks a lot.

- [ ] 59. In discussions I often find I am the realist, keeping people to the point and avoiding wild speculations.
- [ ] 60. I like to ponder many alternatives before making up my mind.
- [ ] 61. In discussions with people I often find I am the most dispassionate and objective.
- [ ] 62. In discussions I'm more likely to adopt a 'low profile' than to take the lead and do most of the talking.
- [ ] 63. I like to be able to relate current actions to a longer term bigger picture.
- [ ] 64. When things go wrong I am happy to shrug it off and 'put it down to experience'.
- [ ] 65. I tend to reject wild, spontaneous ideas as being impractical.
- [ ] 66. It's best to think carefully before taking action.
- [ ] 67. On balance I do the listening rather than the talking.
- [ ] 68. I tend to be tough on people who find it difficult to adopt a logical approach.
- [ ] 69. Most times I believe the end justifies the means.
- [ ] 70. I don't mind hurting people's feelings so long as the job gets done.
- [ ] 71. I find the formality of having specific objectives and plans stifling.
- [ ] 72. I'm usually one of the people who puts life into a party.
- [ ] 73. I do whatever is expedient to get the job done.
- [ ] 74. I quickly get bored with methodical, detailed work.
- [ ] 75. I am keen on exploring the basic assumptions, principles andtheories underpinning things and events.
- [ ] 76. I'm always interested to find out what people think.
- [ ] 77. I like meetings to be run on methodical lines, sticking to laid down agenda, etc.
- [ ] 78. I steer clear of subjective or ambiguous topics.
- [ ] 79. I enjoy the drama and excitement of a crisis situation.
- [ ] 80. People often find me insensitive to their feelings.

## B.2 Scoring And Interpreting The LSQ

The LSQ was scored and interpreted according to the procedure established by Honey and Mumford (described in The Manual of Learning Styles, 1992). Honey and Mumford provide a variety of norms with which the scores of individuals may be compared in order to aid interpretation. However, these norms were unsuitable for interpreting the scores of the students within the population chosen for this research. Therefore, an alternative norm, based on the target population itself, was established. A description of the method employed in scoring the LSQ, and establishing norms for its interpretation, are provided in Sections B.2.1 and B.2.2 respectively.

### B.2.1 A Description Of The Procedure For Scoring And Interpreting The LSQ

Honey and Mumford (1992) provide a score sheet for rating responses to the LSQ, part of which is shown in Figure B1.

Figure B1
Honey And Mumford's Scores Sheet For The LSQ

LEARNING STYLES QUESTIONNAIRE - SCORING

| | | | | |
|---|---|---|---|---|
| | 2 | 7 | 1 | 5 |
| | 4 | 13 | 3 | 9 |
| | 6 | 15 | 8 | 11 |
| | 10 | 16 | 12 | 19 |
| | 17 | 25 | 14 | 21 |
| | 23 | 28 | 18 | 27 |
| | 24 | 29 | 20 | 35 |
| | 32 | 31 | 22 | 37 |
| | 34 | 33 | 26 | 44 |
| | 38 | 36 | 30 | 49 |
| | 40 | 39 | 42 | 50 |
| | 43 | 41 | 47 | 53 |
| | 45 | 46 | 51 | 54 |
| | 48 | 52 | 57 | 56 |
| | 58 | 55 | 61 | 59 |
| | 64 | 60 | 63 | 65 |
| | 71 | 62 | 68 | 69 |
| | 72 | 66 | 75 | 70 |
| | 74 | 67 | 77 | 73 |
| | 79 | 76 | 78 | 80 |
| Totals | | | | |

The 80 statements included within the LSQ may be divided into one of four categories depending on whether they relate to characteristics consistent with the Activist, Reflector, Theorist or Pragmatist learning styles. Within the questionnaire itself, the statements do not appear in any order. The score sheet unscrambles the statements and divides them into groups of 20. Each statement on the LSQ with which the respondent agrees must be indicated on the score sheet with a tick. The total number of statements ticked for each learning style is then calculated. This provides raw scores for each of the four learning styles. These scores must then be interpreted.

The approach used by Honey and Mumford in interpreting the raw scores is to establish norms with which individual scores may be compared. The norms result from analysing the actual scores of people who have completed the questionnaire. Honey and Mumford provide norms based on the responses of a variety of people within particular occupations, for example, 262 Research and Development Managers and 198 Police Sergeants. The norms for the 262 Research and Development Managers are shown in Table B1.

Table B1
Norms For The 262 Research And Development Managers

| | Very strong preference | Strong preference | Moderate preference | Low preference | Very low preference |
|---|---|---|---|---|---|
| Activist | 13 - 20 | 10 - 12 | 6 - 9 | 4 - 5 | 0 - 3 |
| Reflector | 18 - 20 | 16 - 17 | 13 - 15 | 10 - 12 | 0 - 9 |
| Theorist | 17 - 20 | 15 - 16 | 12 - 14 | 9 - 11 | 0 - 8 |
| Pragmatist | 17 - 20 | 15 - 16 | 12 - 14 | 9 - 11 | 0 - 8 |

A suitable norm was required for interpreting the learning style scores of the research population. None of the norms provided by Honey and Mumford were particularly suitable for this purpose as the populations used in their calculation bear little resemblance to the population selected for this research. A norm for the research was therefore calculated using the scores of the 246 second year students within the research population who completed the LSQ correctly. The size of this sample is comparable with the samples on which Honey and

Mumford's norms were based. Section B.2.2 describes the method used in calculating the norm.

### B.2.2 Establishing A Norm For The Research Population

The raw scores for each student were obtained by totalling the number of statements which were ticked on the LSQ for each learning style. Possible values for the raw score range from between 1 and 20, there being 20 statements for each learning style. The number of students obtaining each possible score was then calculated. The cumulative score was also calculated. These are shown in Table B2.

Table B2
Raw Scores For The LSQ And The Number Of Students Achieving Them

| **Raw Scores** | **Activists** | | **Reflectors** | | **Theorists** | | **Pragmatists** | |
|---|---|---|---|---|---|---|---|---|
| | *No of students* | *Cumulative Score* | *No of students* | *Cumulative Score* | *No of students* | *Cumulative Score* | *No of students* | *Cumulative Score* |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| 2 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| 3 | 3 | 4 | 1 | 1 | 3 | 3 | 0 | 1 |
| 4 | 4 | 8 | 3 | 4 | 4 | 7 | 1 | 2 |
| 5 | 11 | 19 | 3 | 7 | 9 | 16 | 1 | 3 |
| 6 | 17 | 36 | 2 | 9 | 7 | 23 | 10 | 13 |
| 7 | 14 | 50 | 4 | 13 | 17 | 40 | 10 | 26 |
| 8 | 28 | 78 | 79 | 20 | 20 | 60 | 14 | 37 |
| 9 | 17 | 95 | 12 | 29 | 21 | 81 | 20 | 57 |
| 10 | 22 | 117 | 13 | 41 | 29 | 110 | 24 | 81 |
| 11 | 30 | 147 | 21 | 54 | 24 | 134 | 32 | 113 |
| 12 | 33 | 180 | 26 | 75 | 38 | 172 | 39 | 152 |
| 13 | 25 | 205 | 23 | 101 | 40 | 212 | 25 | 177 |
| 14 | 25 | 230 | 28 | 124 | 21 | 233 | 29 | 206 |
| 15 | 16 | 246 | 28 | 152 | 12 | 245 | 24 | 230 |
| 16 | 8 | 254 | 38 | 180 | 6 | 251 | 17 | 247 |
| 17 | 2 | 256 | 21 | 218 | 7 | 258 | 7 | 254 |
| 18 | 4 | 260 | 1 | 239 | 4 | 262 | 7 | 261 |
| 19 | 3 | 263 | 9 | 258 | 1 | 263 | 3 | 264 |
| 20 | 1 | 264 | 6 | 264 | 1 | 264 | 0 | 264 |

Honey and Mumford (1992) explain that the norms are calculated by dividing the raw scores into five bands. These are as follows.

A the point at which 10% of the scores are above and 90% are below.
B the point at which 30% of the scores are above and 70% are below.
C the middle 40% of scores with 20% above and 20% below.
D the point at which 70% of the scores are above and 30% are below.
E the point at which 90% of the scores are above and 10% are below.

Each band represents the strength of a person's learning style preference. Any scores in band A indicate a very strong preference; scores in band B indicate a strong preference; scores in band C indicate moderate preferences; scores in band D indicate low preferences; and scores in band E indicate a very low preference.

The raw scores in Table B2 were divided into these bands. Examples of the procedure employed in calculating bands A and B are given below.

*Band A*

Band A refers to the point at which 10 percent of the cumulative scores are above and 90 percent are below. This point was calculated to be 237.6 (90 percent of 264). As each score must be a whole figure, this was rounded up to 238. Thus, each cumulative score of 238 and above lies in band A; each cumulative score of 237 or below lies in either band B, C, D or E.

*Band B*

Band B refers to the point at which 30 percent of the cumulative scores are above and 70 percent are below. This point was calculated to be 184.8 (70 percent of 264). As each score must be a whole figure, this was rounded up to 185. Thus, each cumulative score of between 185 and 237, lies in band B; each cumulative score of 184 or below lies in either band, C, D or E.

Bands D and E were established by the same method, calculating 30 percent and 10 percent of 264, respectively. Band C, the middle 40 percent of scores, was indicated by the range of scores remaining when bands A, B, D and E had been established.

The final bands are as follows.

| | |
|---|---|
| A | scores between 238 and 264 |
| B | scores between 185 and 237 |
| C | scores between 79 and 184 |
| D | scores between 26 and 78 |
| E | scores between 0 and 25 |

These bands are related to LSQ scores. For example, each cumulative score of 238 and above relates to an LSQ score of between 15 and 20 for Activists; 18 and 20 for Reflectors; 15 and 20 for Theorists; and between 16 and 20 for Pragmatists. This can be calculated from the data in Table B2. The range of LSQ scores for each learning style form the basis for the norms on which to interpret the LSQ scores of any student within the target population. The norms for each group are shown in Table B3.

Table B3
Norms For The Four Learning Style Groups (Based On The Responses Of 246 Students Within The Target Population)

| | Very strong preference | Strong preference | Moderate preference | Low preference | Very low preference |
|---|---|---|---|---|---|
| Activist | 15 - 20 | 13 - 14 | 9 - 12 | 6 - 8 | 1 - 5 |
| Reflector | 18 - 20 | 17 | 13 - 16 | 9 - 12 | 1 - 8 |
| Theorist | 15 - 20 | 13 - 14 | 9 - 12 | 7 - 8 | 1 - 6 |
| Pragmatist | 16 - 20 | 14 - 15 | 10 - 13 | 8 - 9 | 1 - 7 |

A modified score sheet was produced on which to record each student's response to the LSQ. This score sheet is reproduced in Figure B2.

Figure B2
Score Sheet For Recording LSQ Scores

# LEARNING STYLES QUESTIONNAIRE - SCORING

| | | | | |
|---|---|---|---|---|
| | 2 | 7 | 1 | 5 |
| | 4 | 13 | 3 | 9 |
| | 6 | 15 | 8 | 11 |
| | 10 | 16 | 12 | 19 |
| | 17 | 25 | 14 | 21 |
| | 23 | 28 | 18 | 27 |
| | 24 | 29 | 20 | 35 |
| | 32 | 31 | 22 | 37 |
| | 34 | 33 | 26 | 44 |
| | 38 | 36 | 30 | 49 |
| | 40 | 39 | 42 | 50 |
| | 43 | 41 | 47 | 53 |
| | 45 | 46 | 51 | 54 |
| | 48 | 52 | 57 | 56 |
| | 58 | 55 | 61 | 59 |
| | 64 | 60 | 63 | 65 |
| | 71 | 62 | 68 | 69 |
| | 72 | 66 | 75 | 70 |
| | 74 | 67 | 77 | 73 |
| | 79 | 76 | 78 | 80 |
| Totals | ________ | ________ | ________ | ________ |

| ACTIVIST | REFLECTOR | THEORIST | PRAGMATIST | |
|---|---|---|---|---|
| 20 | 20 | 20 | 20 | |
| 19 | 19 | 19 | 19 | |
| 18 | 18 | 18 | 18 | Very Strong |
| 17 | | 17 | 17 | |
| 16 | | 16 | 16 | |
| 15 | | 15 | | |
| 14 | 17 | 14 | 15 | Strong |
| 13 | | 13 | 14 | |
| 12 | 16 | 12 | 13 | |
| 11 | 15 | 11 | 12 | Moderate |
| 10 | 14 | 10 | 11 | |
| 9 | 13 | 9 | 10 | |
| 8 | 12 | 8 | 9 | |
| 7 | 11 | 7 | 8 | Low |
| 6 | 10 | | | |
| | 9 | | | |
| 5 | 8 | 6 | 7 | |
| 4 | 7 | 5 | 6 | |
| 3 | 6 | 4 | 5 | |
| 2 | 5 | 3 | 4 | Very Low |
| 1 | 4 | 2 | 3 | |
| | 3 | 1 | 2 | |
| | 2 | | 1 | |
| | 1 | | | |

## B.3 Descriptions Of Honey And Mumford's Four Learning Styles (Honey and Mumford, 1992)

Activists

Activists involve themselves fully and without bias in new experiences. They enjoy the here and now and are happy to be dominated by immediate experiences. They are open-minded, not sceptical, and this tends to make them enthusiastic about anything new. Their philosophy is: "I'll try anything once". They tend to act first and consider the consequences afterwards. Their days are filled with activity. They tackle problems by brainstorming. As soon as the excitement from one activity has died down they are busy looking for the next. They tend to thrive on the challenge of new experiences but are bored with implementation and longer term consolidation. They are gregarious people constantly involving themselves with others but, in doing so, they seek to centre all activities around themselves.

Reflectors

Reflectors like to stand back to ponder experiences and observe them from many different perspectives. They collect data, both first hand and from others, and prefer to think about it thoroughly before coming to any conclusion. The thorough collection and analysis of data about experiences and events is what counts so they tend to postpone reaching definitive conclusions for as long as possible. Their philosophy is to be cautious. They are thoughtful people who like to consider all possible angles and implications before making a move. They prefer to take a back seat in meetings and discussions. They enjoy observing other people in action. They listen to others and get the drift of the discussion before making their own points. They tend to adopt a low profile and have a slightly distant, tolerant unruffled air about them. When they act is it part of a wide picture which includes the past as well as the present and others' observations as well as their own.

Theorists

Theorists adapt and integrate observations into complex but logically sound theories. They think problems through in a step by step logical way. They assimilate disparate facts into coherent theories. They tend to be perfectionists who won't rest easily until things are tidy and fit into a rational scheme. They like to analyse and synthesise. They are keen on basic assumptions, principles, theories, models and systems thinking. Their philosophy prizes rationality and logic. "If it's logical it's good". Questions they frequently ask are: "Does it make sense?" "How does this fit with that?" "What are the basic assumptions?" They tend to be detached, analytical and dedicated to rational objectivity rather than anything subjective or ambiguous. Their approach to problems is consistently logical. This is their "mental set" and they rigidly reject anything that doesn't fit with it. They prefer to maximise certainty and feel uncomfortable with subjective judgements, lateral thinking and anything flippant.

Pragmatists

Pragmatists are keen on trying out ideas, theories and techniques to see if they work in practice. They positively search out new ideas and take the first opportunity to experiment with applications. They are the sort of people who return from management courses brimming with new ideas that they want to try out in practice. They like to get on with things and act quickly and confidently on ideas that attract them. They tend to be impatient with ruminating and open-ended discussions. They are essentially practical, down to earth people who like making practical decisions and solving problems. They respond to problems and opportunities "as a challenge". Their philosophy is: "There is always a better way" and "If it works it's good".

# APPENDIX C

## The Pre-Test Questionnaire

## C.1 The Pre-Test Questionnaire

Control No. [ ]

**BACKGROUND INFORMATION**

Please indicate your answer to each question by placing a tick in the appropriate box.

For administrative use only

1. Age: 18 - 21 [ ] 22 - 25 [ ] 25 and Over [ ] [ ]

2. Gender: Male [ ] Female [ ] [ ]

3. Course: [ ]
   - Computer Science [ ]
   - Software Engineering [ ]
   - Management Science [ ]
   - Combined Studies (Computing) [ ]
   - Combined Studies (Management Science) [ ]
   - Business Information Systems [ ]
   - Computer Systems for Business [ ]

4. Ethnic Origin: [ ]
   - African [ ] European [ ]
   - Asian [ ] Other (please specify) [ ]

   ..............................

5. Are you an Overseas Student ?

   Yes [ ] No [ ] [ ]

6. Please indicate the most recent occupation held by the head of your family household :

   ................................................................................................ [ ]

7. Please indicate which of the statements below applies to you most : [ ]
   - I enjoy using computers [ ]
   - I am indifferent about using computers [ ]
   - I only use computers when I have to [ ]
   - I avoid using computers at all [ ]

8. How often have you used the following :

| | Always | Sometimes | Rarely | Never | |
|---|---|---|---|---|---|
| OPAC | [ ] | [ ] | [ ] | [ ] | [ ] |
| CD ROM | [ ] | [ ] | [ ] | [ ] | [ ] |
| INTERNET | [ ] | [ ] | [ ] | [ ] | [ ] |
| BIDS | [ ] | [ ] | [ ] | [ ] | [ ] |
| MICROFILM | [ ] | [ ] | [ ] | [ ] | [ ] |
| PAPER SOURCES (books, journals etc) | [ ] | [ ] | [ ] | [ ] | [ ] |
| Windows | [ ] | [ ] | [ ] | [ ] | [ ] |
| Mouse | [ ] | [ ] | [ ] | [ ] | [ ] |
| Wordprocessor | [ ] | [ ] | [ ] | [ ] | [ ] |
| Spreadsheet | [ ] | [ ] | [ ] | [ ] | [ ] |
| Database | [ ] | [ ] | [ ] | [ ] | [ ] |
| Graphics Packages | [ ] | [ ] | [ ] | [ ] | [ ] |

# APPENDIX D

## The Training Programme

A training programme was designed for all students to complete prior to the tasks. An initial version of the training programme was developed and tested with volunteers. Suggestions for possible improvements led to the development of a second, and final, version of the training programme. The two versions of the training programme are contained in Appendices D.1 and D.2, respectively.

## D.1 Training Programme: Version 1

### TRAINING PROGRAMME

*To start the Control Window should be displayed.*

### Control Window

This is the Control Window. It is the starting point for using ELINOR and provides navigation to other windows which you will use in your search for information.

At the top of the window there is a Menu Bar with two pull down menus - Customize and Help. *Click once on the Help menu with your mouse.*

Three items are displayed.

*Click once on the Using Help option*. Using Help contains information on how to use the Help screens contained within ELINOR.

*Return to the Control Window selecting the File Menu and then Exit.* Reselect Help. *Click once on the Help on Active Window F1 option*. Help on Active window F1, provides help on the window which you are currently using (in this case the Control Window). Even though the help screen refers to the Control Window it also provides links to all the other help screens through the buttons at the top of the screen and the words which are underlined.

*Return to the Control Window*. Using Help and Help on Active Window F1 appear in the Help menu in each of ELINOR's windows.

In addition to the Menu Bar you can see that there are also 4 icons displayed in the Control Window. Document is for staff use only. Exit, obviously, exits the programme.

The other two icons represent the 2 ways in which you can find information within ELINOR. *Click on one of these icons*.

*(Note for trainer: now go to the relevant part of the training programme (either Fileroom or Search) depending on the participant's choice).*

## Fileroom Window

The Fileroom Window has two views - the left view and the right view. Each view can be used to display the contents of the Fileroom, the In-basket or the Wastebasket.

The In-basket is used as a temporary holding place for documents which have not yet been filed. The Wastebasket is also a temporary holding place but for documents which are no longer needed.

The Fileroom Window displays the Fileroom. The Fileroom is like a physical fileroom. It contains one or more file cabinets. Each cabinet contains one or more drawers. Each drawer contains folders, folders contain documents and documents contain pages. Cabinets, drawers, folders and documents are referred to as filing objects within ELINOR.

The Fileroom is currently displayed in the right-hand view whereas the In-basket is currently displayed in the left-hand view. It is easy to change the view - just click on the appropriate icon below it. *Display the contents of the Wastebasket in the left-hand view. Display the contents of the In-basket in the right-hand view. Display the Fileroom in both the left-hand and right-hand views*.

To display the contents of cabinets, drawers or folders in the Fileroom double-click on the appropriate icons shown. *Choose a cabinet and open it. Now choose a drawer and open it. Now open a folder*. You can now see all the documents contained within that folder. When you are looking through the Fileroom, ELINOR stacks the appropriate icon for each cabinet, drawer and folder that is opened above the view to help you visualise where you are in the Fileroom. When you want return to a particular level, just single click on the icon of the level you want to view. *Return to the folder level, now the drawer level, and finally, the cabinet level*.

You will only be able to see where documents have been placed within the Fileroom Window. You will not be able to change the filing location of documents yourself as this is done by the staff in charge of ELINOR. Eventually there will be nothing in the In-basket or Wastebasket - all the documents will either be filed in the appropriate cabinets, drawers or folders or deleted altogether.

The Fileroom Window also has a Menu Bar with pull down menus. *Select Help*. The options are similar as for the Control Window except the starting point for Help on Active Window F1 will be help relating to the Fileroom Window.

*Select Commands*. It has only one option - Dismiss. This allows you to leave the Fileroom Window. Alternatively you can click on the Dismiss button at the bottom of the window. *Leave the Fileroom using one of these methods*.

## Search Window

The Search Window uses Clues to find information.

The Menu Bar of the Search Window has 5 pull down menus - Commands, Edit, View, Customize and Help.

*Select the Commands menu.*

Content Search, Label Search and Control Search are the 3 ways in which you can Search for information. You can also use the corresponding buttons at the bottom of the screen. Content and Label Searches are the main ways to search for information.

A Content Search searches through the contents of the text in the documents on ELINOR to find matches to your clue. Because it searches for both exact and similar matches correct spelling is not important when entering your clue. Notice that some of the options are dimmed. *Click the mouse in the grey area outside the Commands menu to close it.*

*Type a clue in the Clue field - you can see the cursor blinking there ready. Now perform a content Search using either the Commands menu or the buttons at the bottom of the screen.*

The results of the Search are shown in a Hit List. Every Hit List has the following information :

Number of Hits
Search Time
Hit number
Document name
Page numbers
A piece of text containing the text matching the clue

You can see everything in the Hit List by scrolling up and down and from left to right using the scroll bars. You can also move around by using the arrow keys or by clicking the mouse once on specific documents. *Try this now using first the scroll bars ... then the arrow keys ... and finally the mouse.*

*Go back to the Commands menu.* Notice that the options which were previously dimmed are available now you have conducted a search.

Previous Hit and Next Hit also allow you to move up and down the Hit List. *Try this now.*

Clear Hit list clears the Hit List from the Search Window. *Do this now.*

A Label Search conducts a search through the labels of documents, folders, drawers and cabinets contained in the Fileroom for matches to your clue. A label refers to the names given to documents, folders, drawers or cabinets. A Label Search does not search through the actual contents of the documents as a Content Search does.

*Perform a label search on the clue you have already chosen. What are the two ways in which you can do this ? (Trainer to prompt trainee if cannot answer: Commands menu and buttons)*

The Hit List looks slightly different when you perform a Label Search. ELINOR displays the label names of filing objects containing matches to your clue. Each item has an icon next to it which indicates the type of filing object it refers to, for example this one *(trainer points to relevant filing object)* is a drawer, this one *(trainer points to relevant filing object)* is a folder.

The Help Menu is exactly the same as before except the starting point for Help on Active Window F1 will be Help relating to the Search Window.

*Re-select the Commands Menu.* The Dismiss option closes the Search Window. Alternatively you can use the corresponding button at the bottom of the screen. *Now close the Search Window using one of these methods.*

## Accessing Documents 1 - Fileroom

Now you know how to Search for information using the Search and Fileroom Windows you need to know how to access the documents you have found. We'll take the Fileroom first.

*Open the Fileroom. Find from the In-basket a document called Business in Context. Select this document to view by double-clicking on it*. The Document Window appears.

***Document Window***

The title of the document you have opened appears at the top of the window. I'll now tell you about the various commands you can use in the Document Window. The Menu Bar has 4 pull down menus Commands, View, Customize and Help.

*Select Commands*. Close clears the current document from the Document Window. Alternatively you could click on the Close button at the bottom of the screen. Dismiss closes the Document Window altogether and again, the button at the bottom of the screen provides an alternative way of doing this. *Clear the Document Window and then dismiss it. Re-open the Document Window by selecting the Business in Context document once more.*

ELINOR has two types of pages. Image pages which are created by scanning documents into the system and text pages which are created by a process called Optical Character Recognition.

In ELINOR, every text page has a matching image page but every image page does not have a matching text page due to copyright issues. You can view the image pages and text pages of a particular document depending on their availability.

When you first open the Document Window the commands which let you access text and image pages are dimmed. You can see this by opening the View menu. The corresponding buttons which also let you access text and image pages are also dimmed. Before you can use them you must highlight the page you want to view. *Click once on a page to Highlight it.*

*Reselect the View menu and see that the options are now available.* The corresponding buttons have become available also. You may scroll up and down the pages listed using the scroll bar at the right-hand side of the screen. Alternatively you may use the arrow keys or by clicking your mouse once on specific documents. *Move up and down the list using first the scroll bar ... the arrow keys ... and then the mouse.*

*Now select the View menu and choose Text Page*. The page will appear in a Text Window. *Now dismiss the Text Window by selecting Commands and Dismiss.* You may also access the text page by selecting the corresponding button at the bottom of the screen. *Reselect the same page and do this now. Dismiss the Text Window once more*.

It is the same procedure for viewing image pages. We'll do it the other way round now. *Re-select the page and use the button at the bottom of the screen to view it*. The page appears in an Image Window. *Dismiss the Image Window by selecting Commands and Dismiss, reselect the page and do the same thing using the View menu. Dismiss the Image Window once more.*

Sometimes, even when a page has been highlighted, the text command and button may be dimmed. This signifies that there is no text associated with that page and you cannot view it in that format. Alternatively, the image command and button may remain dimmed. This signifies that there is no image associated with that page and you cannot view it in that format. *Go back to the Fileroom and select "A Simple Way to find Chaos" from the In-basket to view. Highlight a page. Which options under the View Menu are dimmed ? Which buttons are dimmed* ? There is only an image associated with this page as the text options are dimmed.

*Reselect the View menu.* The Fileroom option allows you to see where in the Fileroom the document you are viewing is filed. *Choose Fileroom*. The Fileroom is opened and ELINOR indicates the filing location of your chosen document. *Dismiss the Fileroom Window to return.* You can also use the corresponding button at the bottom of the screen to view the filing location of a document. *Do this now and then return to the Document Window.*

*Dismiss the Document Window and Open the Search Window from the Control Window in order to do this.*

## Accessing Documents 2 - Search Window

*Delete the previous clue in the clue field and perform a Content Search on the word "Computer".*

*Select a page to view.*

*Select the View menu.* The Text option allows you to view the text page associated with the page you have chosen. *Choose this option. Now dismiss the Text Window.* Alternatively double-clicking with the left mouse button will open the page. The page will automatically appear. *Try this now.*

All documents have at least one text page (usually a contents page or index). In the Search facility it is these pages which are searched for matches to your clue. As such, the pages listed in the Hit List will all have text pages and will therefore usually be contents or index pages. You can then use these to find the relevant pages in the document to gain information on your topic.

Similarly, the Image option under the View menu allows you to view the image page associated with the page you have chosen. *Do this now.*

The Document option under the View menu allows you to see the Document Window corresponding to the page currently being displayed. *Choose Document to see this. Dismiss the Document Window to return.*

The Fileroom option allows you to see where in the Fileroom the document you are viewing is filed. *Choose Fileroom.* The Fileroom is opened and ELINOR indicates the filing location of your chosen document. *Dismiss the Fileroom Window to return.*

*Now perform a Label Search.*

Open the View menu. Notice that even when you highlight an entry in the Hit List the Text page and Image page options remain dimmed. However, you may see where in the Fileroom and Document Windows items are placed by clicking on the relevant options under the View Menu as before.

*Clear the Hit List and Dismiss the Search Window.*

Now you know how to access documents through both the Fileroom and Search Windows I'll tell you how to view them through the commands in each of the Text and Image Windows.

## Viewing Documents 1 - Image Window

*Search for a document in any way you wish and find an image page to view.*

The Menu Bar of the Image Window has 6 pull-down menus - Commands, Next!, Previous!, View, Customize and Help.

Next! and Previous! allow you to view the next page and previous page in sequence from the page currently displayed. *Have a go at this and notice the page number changing at the top of the screen.*

*Now select the Commands menu.* Go To Page again displays a dialog box where you can enter the number of the image page you want to view. The dialog box also indicates the total number of pages in the document. *Use Go To Page to display an image page of your choice.*

*Select the View menu.* This contains three options. If there is a text page corresponding to the image page currently being viewed the Matching Text Page option will let you view it. *Click on this option to see if there is a matching text page. (If there is one, use the Dismiss option under the Commands menu to return to the Image Window).* The Document option allows you to see the Document Window corresponding to the page currently being displayed. *Choose Document to see this. Dismiss the Document Window to return.* The Fileroom option allows you to see where in the Fileroom the document to which the page belongs is filed. *Choose Fileroom to see this. Dismiss the Fileroom Window.*

*Now select the Customize menu.*

As each Image Window is opened, the previous one is automatically closed. However, the Lock command allows you display up to four Image Windows at a time.

*Choose the Lock command.* See that ELINOR indicates the page has been locked at the top of the screen. *Select the Customize menu again.* A check mark has also appeared next to the command in the menu. *Now minimise the Image Window. Select a second image page from the Search Window, lock it and minimise it. Now click on the first image page which is represented by an icon at the bottom of the screen.* It is still open. *Now select the Customize menu and choose the Lock command once more.* See that the indication of it being locked at the top of the screen has disappeared. *Select the Customize menu again.* The check mark has disappeared also. The page is no longer locked.

The Help menu is exactly the same as before except the starting point for Help on Active Window F1 will be Help relating to the Image Window.

There are several other functions you need to know about. These are :

Rotating an image
Magnifying an image
Panning an image

Rotating an image.

*Select the Customize menu again and Image Parameters.* A dialog box appears. The top left hand side of the box deals with image viewing options. You can rotate the image in 90 degree increments using the arrows by clicking on the arrow showing the angle of rotation you want. You can also set the value in the "Angle" box. When you have set the angle of rotation choose "Apply". If there is nothing else you want to change choose "OK" to close the dialog box.

*Rotate the image in the Image Window 90 degrees clockwise using the arrows. Choose "Apply".* You can see the document in the Image Window behind the dialog box has rotated 90 degrees. *Now rotate it a further 90 degrees using the Angle box and typing in 180, "Apply" and "OK" to close the dialog box.*

Magnifying (or demagnifying) an image.

There are four ways in which you may do this.

Since I have just introduced you to the Image Parameters dialog box we will start here. The Scale Box identifies the current magnification. A setting of about 30% usually represents actual size. A setting of 100% displays the image about three times actual size. *Change the Scale box setting to 100% and choose "Apply". Now change the image back to 30% actual size. Close the Image Parameters box.*

The second way in which you can magnify an image is by double clicking the right mouse button on the image page. This will magnify the image in 10% increments. Double click the left mouse button to demagnify the image in 10% increments. *Have a go at this now.*

The third way is by using the Show Scale Bar option from the Customize menu. *Select this now.* You can choose the required magnification by dragging the tab with your mouse. *Have a go at this.*

Finally you can make certain parts of the image page bigger by clicking and dragging your right mouse button around a specific area. You will see an outline around the area you are about to magnify. *Have a go at this.* Remember that you can demagnify by using the Scale Box from the Image Parameters box or Scale Bar in the Customize menu or by double clicking the left mouse button.

Panning an Image

If you have magnified the image and you want to see a different part of what is displayed you can easily pan or move across the image.

There are two ways in which you may do this.

Use the left mouse button to click and drag in the direction you want to view. You could also use the scroll bars of the window. Try both of these.

## Viewing Documents 2 - Text Window

_Display a text page._

The first thing you may notice when you enter a Text Window is that it does not fit into the whole screen. You may scroll up and down the page using the scroll bars at the right-hand side and bottom of the screen. _Do this now._

The Text Window menus are very similar to those for the Image Window.

Next! and Previous! allow you to view the next page and previous page in sequence from the page you are currently viewing. _Have another go at this._ If there is no text for the page it will tell you. In this case you must first view the image page matching the current text page and view your chosen page in image format.

_Now select the Commands menu._ Go To Page again displays a dialog box where you can enter the number of the text page you want to view. Again, this dialog box also indicates the total number of pages in the document. If there is no text page for the page you want to view (it will tell you if there isn't) you must view the image page matching the current text page and then use the Image Window commands to jump to your chosen page. _Use Go To Page to display a page of your choice._

_Select the View menu._ This again contains three options. Matching image page allows you to view the image page corresponding to the text page currently being viewed. _Click on this option to view the matching image page._ It appears in an Image Window. _Use the Dismiss option under the Commands menu in the Image Window to return to the Text Window. Select the View menu again._ The Document option under the View menu allows you to see the Document Window corresponding to the page currently being displayed. _Choose Document to see this._ _Dismiss the Document Window to return. Reselect the View menu a third time._ The Fileroom option allows you to see where in the Fileroom the document to which the page belongs is filed. _Choose Fileroom to see this._ _Dismiss the Fileroom Window._

_Select the Customize menu._ This contains 3 options.

The Lock option works in the same way as for the Image Window. You can lock a Text Window open so when another is selected it will not be replaced. Just like before, you can display up to four Text Windows at a time.

_Choose the Lock command._ See that ELINOR indicates the page has been locked at the top of the screen. _Select the Customize menu again._ A check mark has also appeared next to the command in the menu. _Now minimise the Text Window. Select a second text page from the Document Window, lock it and minimise it. Now click on the first text page which is represented by an icon at the bottom of the screen._ It is still open. _Now select the Customize menu and choose the Lock command once more._ See that the indication of it being locked at the top of the screen has disappeared. _Select the Customize menu again._ The check mark has disappeared also. The page is no longer locked. The Lock command only works when pages are selected directly from the Document Window. If pages are selected using Next! or Previous! each subsequent page will replace the first.

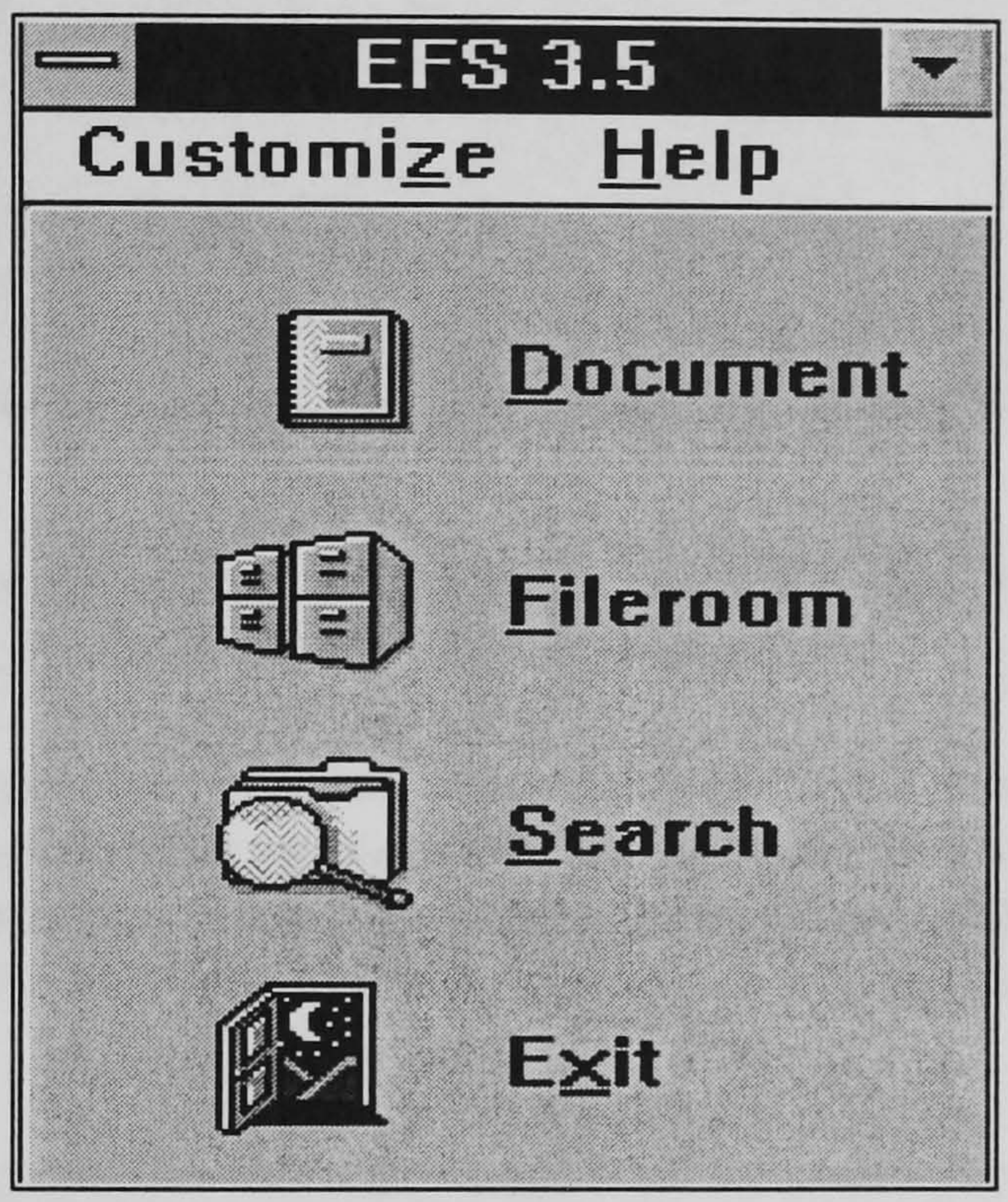
The Help menu is exactly the same as before except the starting point for Help on active Window F1 will be Help relating to the Text Window:

## D.2 Training Programme: Version 2

### ELINOR TRAINING PACKAGE

This training package is designed to give you the basic knowledge needed to operate the ELINOR Electronic Library. It does not cover every facility available for use within the system.

The starting point for using ELINOR is the **Control Window**.




At the top of the window there is a **Menu Bar** with two pull down menus. *Click once on the **Help** menu with your mouse.*

**Using Help** contains information on how to use the Help screens contained within ELINOR.

**Help on Active Window F1**, provides help on the window which you are currently using (in this case the Control Window).

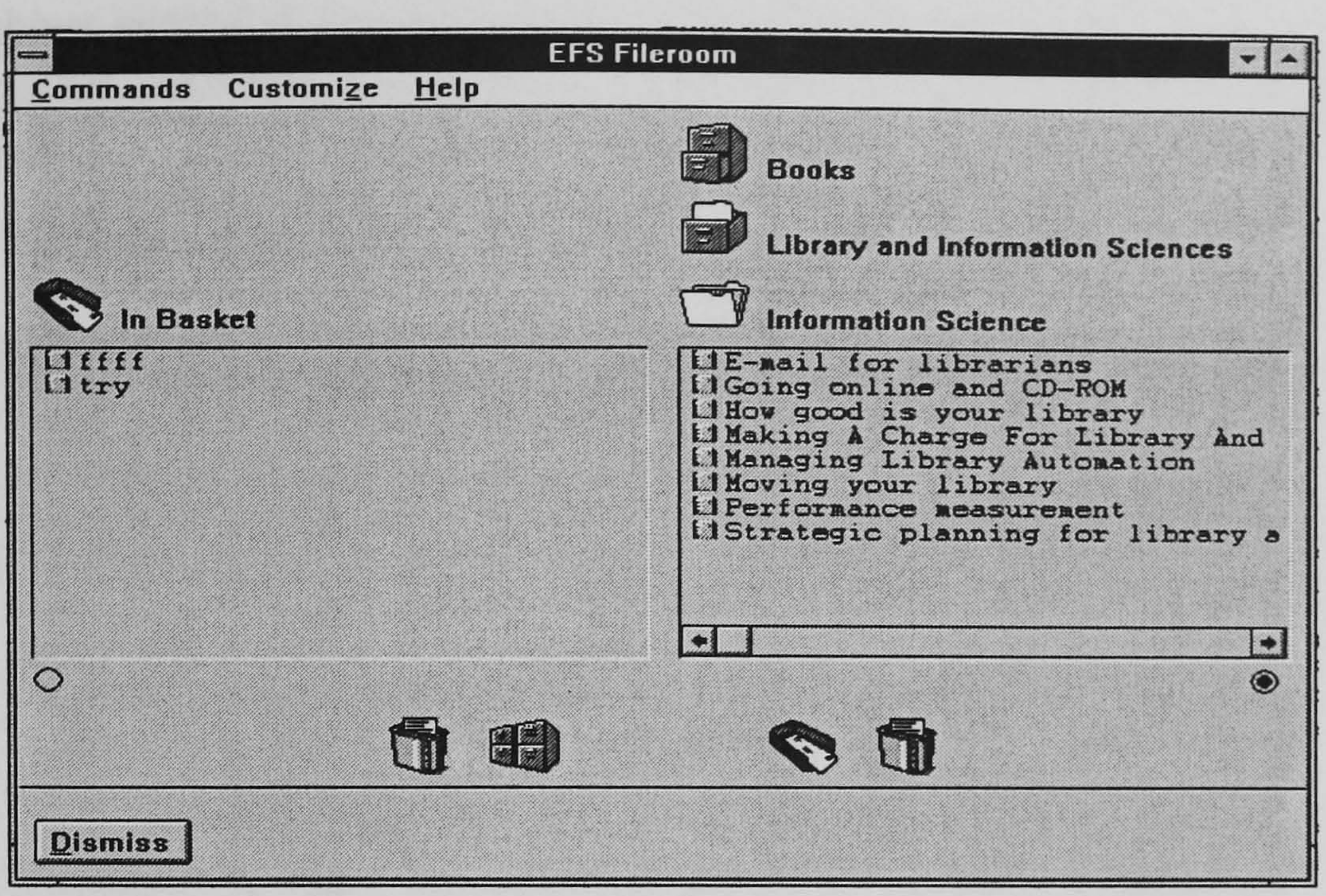
Using Help and Help on Active Window F1 appear in the Help menu in each of ELINOR's windows.

In addition to the Menu Bar you can see that there are 4 icons displayed in the Control Window. **Document** is for staff use only. **Exit**, obviously, exits the programme. You will not use these.

The other two icons represent the 2 ways in which you can find information within ELINOR. *Click on the **Fileroom** icon.*

The **Fileroom Window** appears.

## Finding documents using the Fileroom facility




The Fileroom Window has two views - the left view and the right view. Each view can be used to display the contents of the **Fileroom**, the **In-basket** or the **Wastebasket**.

The In-basket is used as a temporary holding place for documents which have not yet been filed. The Wastebasket is also a temporary holding place but for documents which are no longer needed. The Fileroom is like a physical fileroom. It contains one or more **filing cabinets**; each cabinet contains one or more **drawers**; each drawer contains **folders**, folders contain **documents** and documents contain pages.

The Fileroom is currently displayed in the right-hand view whereas the In-basket is currently displayed in the left-hand view. To change the view just single click on the icons representing the In-basket, Wastebasket and Fileroom below each view. *Practice changing the view now*.

To display the contents of cabinets, drawers or folders in the Fileroom double-click on the appropriate icons within the Fileroom view. *Choose a cabinet and open it. Now choose a drawer and open it. Now open a folder*. You can see all the documents contained within that folder. When you are looking through the Fileroom, ELINOR stacks the appropriate icon for each cabinet, drawer and folder that is opened above the view to help you visualise where you are in the Fileroom. When you want return to a particular level, just single click on the icon of the level you want to view. *Return to the folder level, now the drawer level, and finally, the cabinet level*.

You may move up and down and from left to right in the In-basket and Wastebasket using the **Scroll Bars** or by clicking the mouse once to highlight a document and then using the **arrow keys** or **mouse** to move up and down.

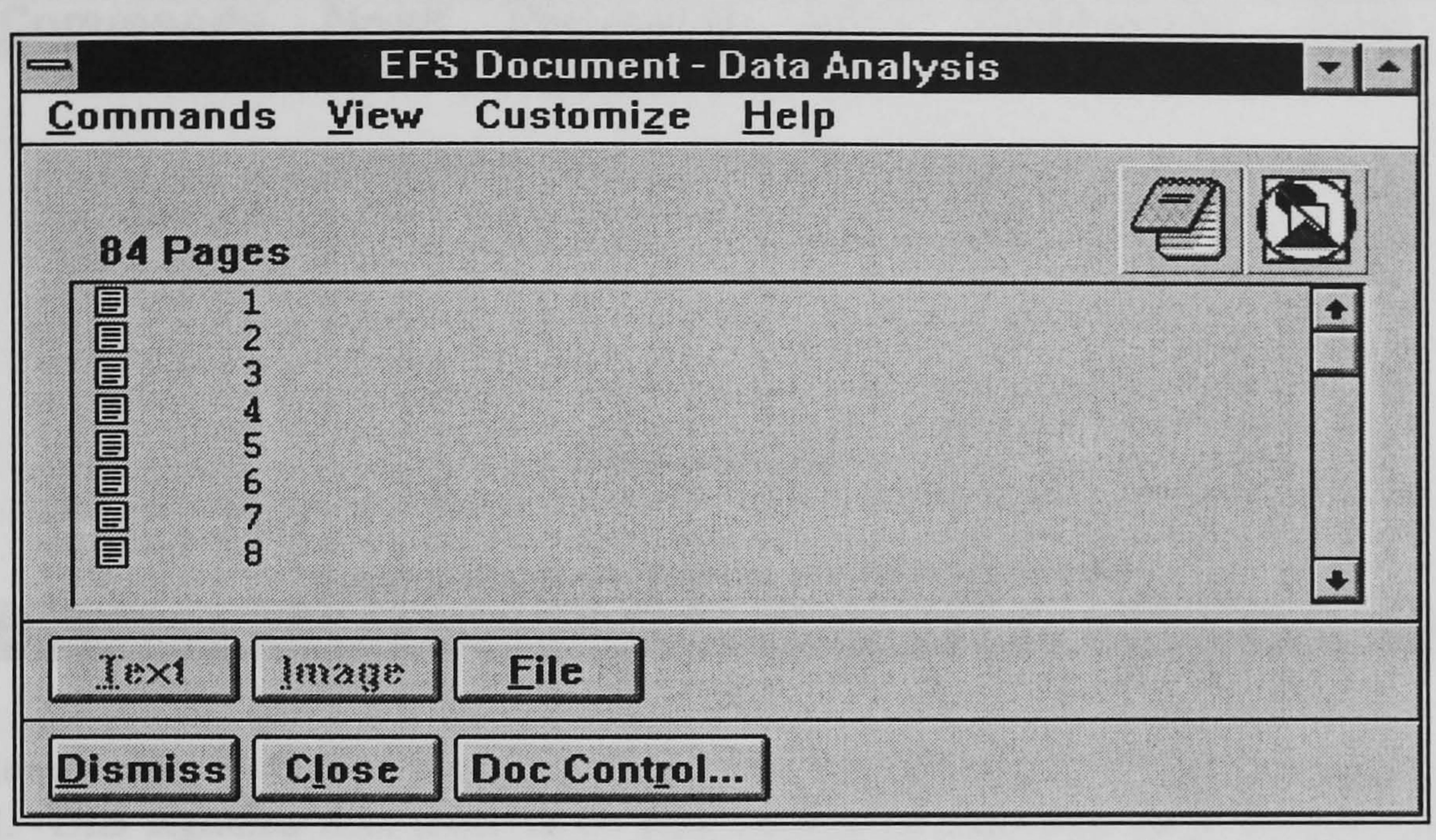
You will only be able to see where documents have been placed within the Fileroom Window. You will not be able to change the filing location of documents yourself as this is done by the staff in charge of ELINOR.

## Viewing Documents

Once you have found a document using the Fileroom Window you need to know how to view the pages within it.

*Find the filing cabinet entitled "Course Material". Open the drawer within it called "Computing (HND)". Find a document called "Data Analysis"from the "Data Modelling" folder. Select this document to view by double-clicking on it* .

The **Document Window** appears.




Notice that the document title appears at the top of the window and the page numbers are listed down the side.

You may scroll up and down the pages listed using the **scroll bar** at the right-hand side of the screen. Alternatively you may click the **mouse** on specific documents or use the **arrow keys** to move up and down. *Move up and down the list using first the scroll bar ... then the mouse ... and then the arrow keys.*

***IMPORTANT***

**So that the true page 1 of a scanned document matches the ELINOR page 1 in the Document Window, any pages preceding the actual page number 1 (such as the title page, contents page and preface) have been relocated within ELINOR. The last few pages of every document which has these preceding pages also contains a page produced by the ELINOR staff showing where these pages may be found. You will be shown how this works when you have learnt how to view image pages.**

You may view pages in either image or text format. **Image Pages** are created by scanning documents into the system. **Text Pages** are created by a process called Optical Character Recognition. In ELINOR, every text page has a matching image page but every image page does not have a matching text page due to copyright issues.

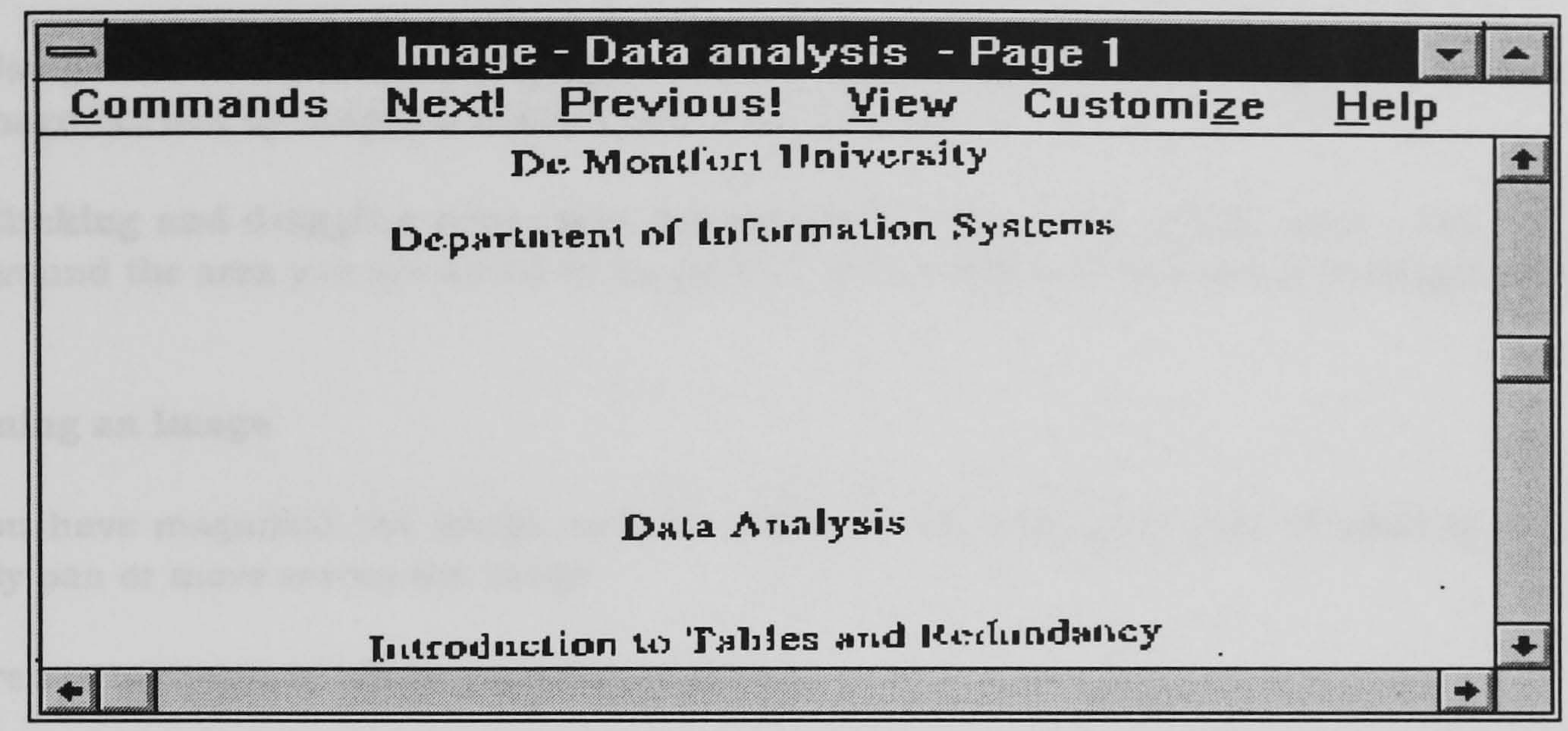
Before you can view pages you must highlight the page you want to view. *Click once on page 1 to Highlight it.*

## Viewing Image Pages

You may view image pages by selecting the **Image Page** option under the **View Menu** in the Document Window or by using the **Image button** at the bottom of the screen.

*View the image page associated with your chosen page using one of these methods.*

The page appears in an **Image Window.**




***TIP*** Sometimes, even when a page has been highlighted, the text command and button may be dimmed. This signifies that there is no text associated with that page and you cannot view it in that format. Alternatively, the image command and button may be dimmed. This signifies that there is no image associated with that page and you cannot view it in that format.

**Next!** and **Previous!** allow you to view the next and previous pages in sequence from the page currently displayed. *Have a go at this. Notice the page number changing at the top of the screen.*

*Now select the Commands Menu*. **Go To Page** displays a dialog box where you can enter the number of the image page you want to view. This dialog box also indicates the total number of pages in the document. *Use Go To Page to display an image page of your choice*.

*Select the **View menu**.* If there is a text page corresponding to the image page currently being viewed the **Matching Text Page** option will allow you to view it. *Try this now. The page appears in a Text Window. Use the Dismiss option under the Commands menu in the Text Window to return to the Image Window.*

There are several other functions within the Image Window which are useful :

### Rotating an image

*Select the **Customize Menu** and **Image Parameters**.* A dialog box appears. You can rotate the image in 90 degree increments by clicking on the **arrow** showing the angle of rotation you want. You can also set the value (in 90 degree increments) in the **Angle box**. When you have set the angle of rotation choose **Apply.** If there is nothing else you want to change choose **OK** to close the dialog box.

**Magnifying (or demagnifying) an image**

There are four ways in which you may do this :

1. Changing the **Scale Box** setting in the Image Parameters dialog box. A setting of about 30% represents actual size. A setting of 100% displays the image about three times actual size.

2. **Double clicking the right mouse button** on the image page will magnify the image in 10% increments. **Double clicking the left mouse button** will demagnify the image in 10% increments.

3. Using the **Show Scale Bar** option from the Customize Menu you can choose the required magnification by dragging the tab with your mouse.

4. **Clicking and dragging your right mouse button** around a specific area. You will see an outline around the area you are about to magnify. You can only use this option to magnify an image.

**Panning an Image**

If you have magnified the image and you want to see a different part of what is displayed you can easily pan or move across the image.

There are two ways in which you may do this. :

1. Using the **left mouse button** to click and drag in the direction you want to view.

2. Using the **scroll bars**.

*Experiment with rotating images, magnifying (and demagnifying) images and panning images using each of the above methods.*

*Select the **Commands Menu** and close the Image Window by selecting **Dismiss**.*

This will take you back to the Document Window.

***IMPORTANT***

**As described earlier, any pages preceding the actual page 1 in a document have been relocated within ELINOR. Documents which have these preceding pages therefore contain an additional page showing where they may be found. These additional pages are usually located at the end of those listed in the document window.**

*Find the last page in the list shown in the Document Window and highlight it with your mouse. View it in image format by selecting the **Image Page** option under the **View Menu** or by using the **Image Button** at the bottom of the screen.*

The ELINOR contents page is shown in the Image Window. The lecture entitled "Introduction to tables and redundancy" is located at page 1. Use the Go To Page option under the Commands Menu to reach this page. You may use the same procedure for viewing any document which has pages preceding the true page one.

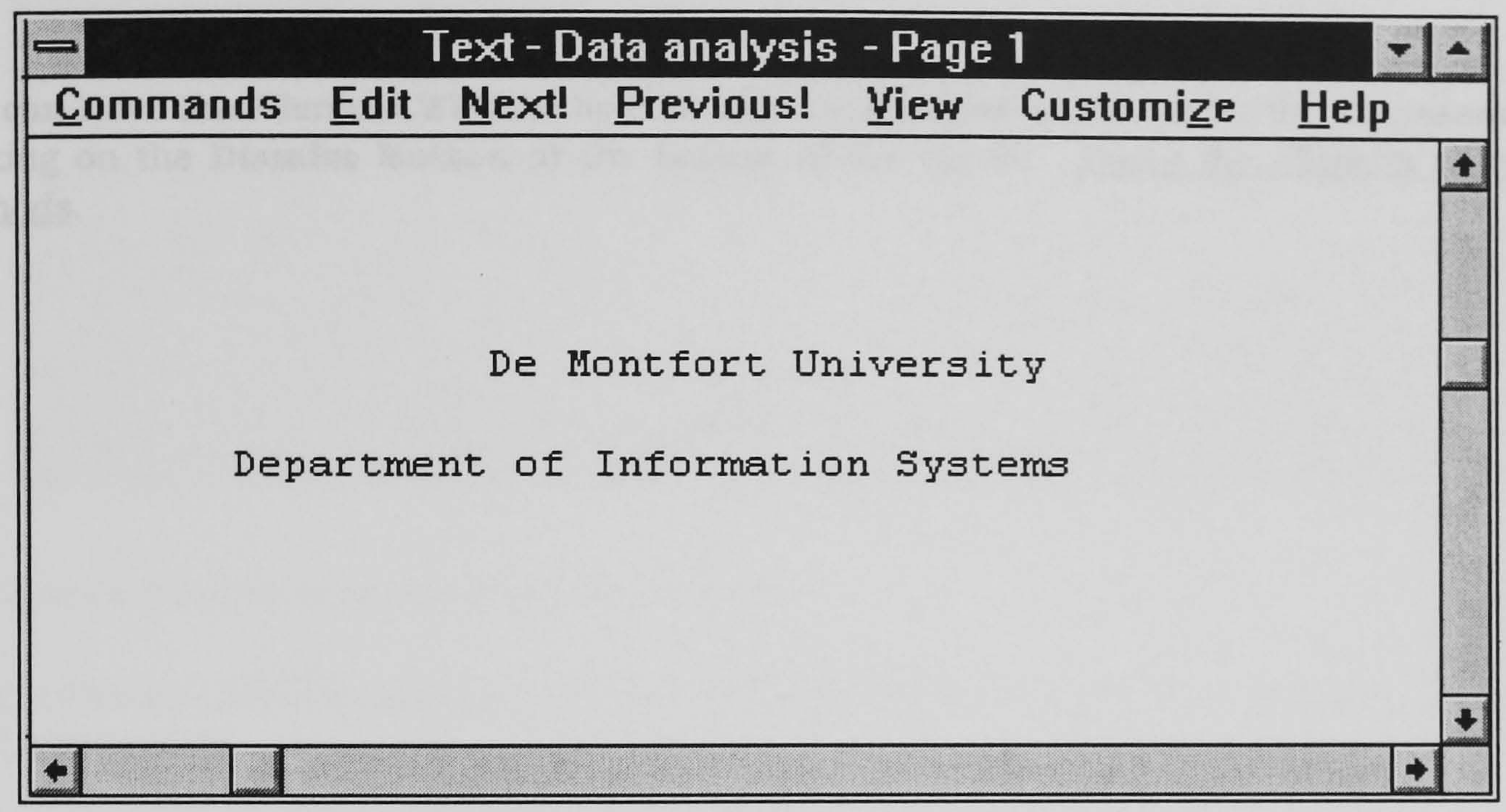
*Return to the Document Window by selecting the **Dismiss** option under the Image Window **Commands Menu**.*

## Viewing Text Pages

You may view text pages by selecting the **Text Page** option under the **View Menu** in the Document Window or by using the **Text button** at the bottom of the screen. *Try this now.*

*Reselect page 1 and view the text page associated with it using one of these methods*

The page appears in an **Text Window.**




The first thing you may notice when you enter a Text Window is that it does not fit into the whole screen. You may scroll up and down the page using the scroll bars at the right-hand side of the screen and from left to right using the scroll bars at the bottom of the screen. *Try this now.*

The Text Window menus are very similar to those for the Image Window.

**Next!** and **Previous!** again allow you to view the next and previous pages in sequence from the page currently being viewed. ELINOR will indicate if there is no text associated with the page.

***TIP*** If there is no text associated with the page you must first view the image page matching the current text page and view the next and previous pages in image format.

*Practice using Next! and Previous!*

*Now select the Commands Menu*. Go To Page again displays a dialog box where you can enter the number of the text page you want to view. Again, this dialog box indicates the total number of pages in the document. *Practice using Go To Page*.

***TIP*** If there is no text associated with the page you want to view (ELINOR will tell you if there isn't) you must view the image page matching the current text page and then use the Image Window commands to jump to your chosen page (which will then appear in image format).

*Select the View menu.* Instead of Matching Text Page, as we saw in the Image Window, we now have **Matching Image Page**. *Click on this option to view the matching image page and then dismiss the Image Window.*

*Dismiss the Text Window by selecting **Dismiss** from the **Commands Menu**.* You have returned to the Document Window.

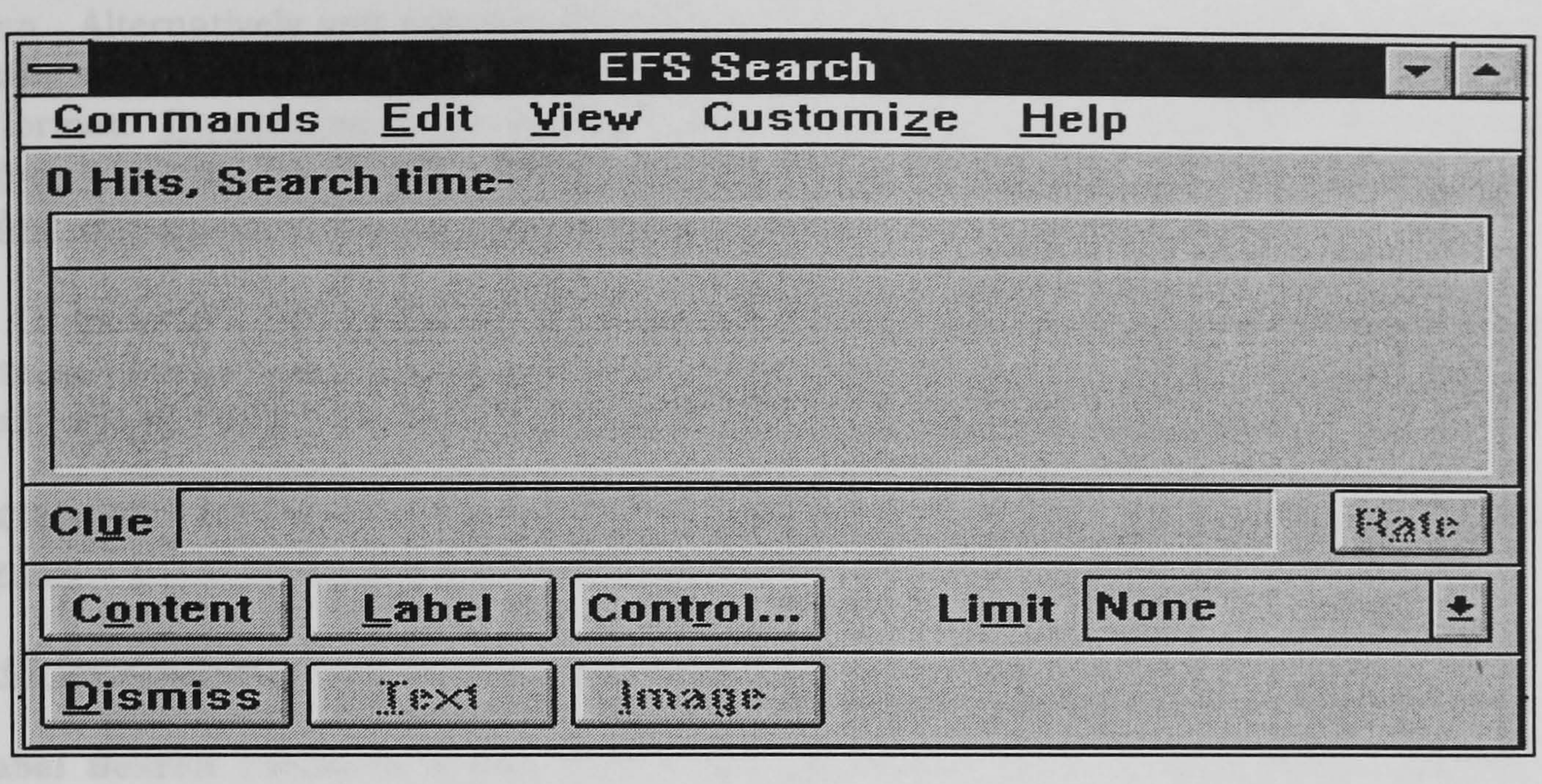
The **Close** option under the **Commands Menu** clears the current document from the Document Window. Alternatively you could click on the **Close Button** at the bottom of the screen.

**Dismiss** closes the Document Window altogether. Again, the **Dismiss Button** at the bottom of the screen provides an alternative way of doing this. *Clear the Document Window and then dismiss it.* You have returned to the Fileroom Window.

You can leave the Fileroom Window by choosing the **Dismiss** option under the **Commands Menu** or by clicking on the **Dismiss Button** at the bottom of the screen. *Leave the Fileroom using one of these methods.*

## Finding documents using the Search facility

Choose the Search Icon from the Control Window. The **Search Window** appears.




The Search Window uses **Clues** to find information.

*Type a clue (use ELINOR as an example) in the* ***Clue field*** *- you can see the cursor blinking there ready. Now press return.*

You can perform several types of search in the Search Window.

## Content Searches

A **Content Search** searches through the contents of the text in the documents on ELINOR to find matches to your clue. Because it searches for both exact and similar matches, correct spelling is not important when entering your clue.

*Perform a Content Search by choosing either the* ***Content Search*** *option under the* ***Commands Menu*** *or by choosing the* ***Content Button*** *at the bottom of the screen.*

The results of the search are shown in a **Hit List**. Every Hit List has the following information :

- Number of Hits
- Search Time
- Hit number
- Document name
- Page numbers
- A piece of text containing the text matching the clue

You can see everything in the Hit List by scrolling up and down and from left to right using the **scroll bars**. You can also move around by clicking the **mouse** once on specific documents or by using the **arrow keys**. *Try this now using first the scroll bars ... then the mouse ... and finally the arrow keys.*

*Open the* ***Commands Menu***. The **Previous Hit** and **Next Hit** options also allow you to move up and down the Hit List. *Try this now.*

*Select the **View Menu**.* The **Image** option allows you to view the Image Page associated with the page you have chosen.

Similarly, the **Text** option will allow you to view the Text Page associated with the page you have chosen. Alternatively you can use the Text and Image Buttons at the bottom of the screen. **Double-clicking** with the **left mouse button** will also open the page. The page will automatically appear in Text format. *Try opening Text and Image pages using each of these methods. Now return to the Search Window by using the Dismiss option under the Commands menu in either the Text Window or Image Window, depending which you are currently viewing.*

***TIP*** All documents have at least one text page (usually a contents page or index). In the search facility it is these pages which are searched for matches to your clue. As such, the pages listed in the Hit List will all have text pages and will therefore usually be contents or index pages.

The **Clear Hit List** option under the **Commands Menu** clears the Hit List from the Search Window. *Do this now.*

## Label Searches

A **Label Search** conducts a search through the names given to documents, folders, drawers and cabinets contained in the **Fileroom** for matches to your clue. It does not search through the actual contents of the documents.

*Perform a Label Search by choosing either the **Label Search** option under the **Commands Menu** or by choosing the **Label Button** at the bottom of the screen.*

The Hit List looks slightly different when you perform a Label search. ELINOR displays the label names of filing objects containing matches to your clue. Each item has an icon next to it which indicates whether it refers to a cabinet, drawer, folder or document.

*Open the View Menu.* Notice that the Text Page and Image Page options remain dimmed. The Text and Image buttons are also dimmed. Therefore you cannot view Text and Image pages directly. However, you may see where in the Fileroom and Document Windows items are placed by clicking on the relevant options under the View Menu. The **Document** option allows you to see the document window corresponding to the page currently being displayed. *Choose Document to see this.* *Dismiss the Document Window to return. Minimise the Control Window which appears*

*Re-open the View Menu.* The **Fileroom** option allows you to see where in the Fileroom the document you are viewing is filed. *Choose Fileroom.* The fileroom is opened and ELINOR indicates the filing location of your chosen document. *Dismiss the Fileroom Window to return.*

*Re-select the Commands Menu.* **Clear Hit List** clears the current Hit List from the Search Window. *Do this now.*

*Re-open the Commands Menu..* The **Dismiss** option closes the Search Window. Alternatively you can use the **Dismiss Button** at the bottom of the screen. *Close the Search Window using one of these methods.*

*Click on the icon representing EFS which appears at the bottom of the screen to return to the Control Window.*

# APPENDIX E

## A Description Of The Logging System And Procedure Used In Determining Patterns Of Information Retrieval

## E.1 Introduction

The logging system (described in Section 6.8.1) was used to gain the data necessary for determining the patterns of information retrieval adopted by each student. The logging system utilises a VGA to TV adaptor which allows the signal from the computer monitor to be projected onto a TV set for recording by a VCR. The logging system captures an image of the entire computer screen, tracking each keystroke or mouse movement made by students. The process of determining patterns of information retrieval from the data generated by the logging system is described, by example, in Section E.2.

## E.2 Use Of The Logged Data In Determining Information Retrieval Patterns

A transcription of the data from the logging system was undertaken in order to create a written record of each document and operational facility used by each student in each of the three tasks. A written record was necessary to facilitate input of the data into a computer program for ease of analysis. The transcription required each recorded session to be viewed and notes made regarding the details of each document and operational facility used. An example of the transcription for one student (reference number 125) is included below:

<u>Task 1</u>

The **Control Window** is active
The Search facility is selected from the Control Window : **Search Window** opens
A Clue is entered : "Expert Systems"
A Content Search is performed by pressing Return
Use of the Scroll Bars to view the hit list
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Expert Systems : Tools and Applications"
Next
Previous
View Document option is selected from the View Menu : **Document Window** opens
Dismiss Button is selected to return to the **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
Use of Scroll Bars to view the hit list
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Expert Systems : Tools and Applications"
Next

Previous used 17 times
Go To Page option is selected from the Commands Menu to reach a further text page
Next used 4 times
Text Parameters Dialog Box is selected from the Customise Menu. However, no further use is made of this facility and the OK button is selected to close the dialog box
Matching Image Page option is selected from the View Menu : **Image Window** opens
Scroll Bars used to view the content of the document
Previous used 3 times
Next
Previous used twice
Go To Page option is selected from the Commands Menu to reach a further image page
Next
Go To Page option is selected from the Commands Menu
Next used twice
Dismiss option is selected from the Commands Menu to return to **Text Window**
Matching Image Page option is selected from the View Menu : **Image Window** opens
Next used twice
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
Clear Hit List option is selected from the Commands Menu
Dismiss option is selected from the Commands Menu to return to **Control Window**
Restores the **Control Window** which is represented by an icon at the bottom of the screen

Task 2

The Control Window is active
The Search facility is selected from the Control Window : **Search Window** opens
A Clue is entered : "Social aspects of computing"
A Content Search is performed by pressing Return
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "BIS Year 2, 1993, Examination Papers"
Next
Use of Scroll Bars to view the content of the document
Dismiss option is selected from the Commands Menu to return to **Search Window**
Dismiss option is selected from the Commands Menu to return to **Control Window**

Task 3

The **Control Window** is active
The Search facility is selected from the Control Window : **Search Window** opens
A Clue is entered : "Prototyping in information systems"
A Content Search is performed by pressing Return
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Prototyping"
Previous is used twice
Next is used six times
Scroll Bars
Previous
Scroll Bars
Previous
Scroll Bars
Next
Scroll Bars

Go To Page option is selected from the Commands Menu and used 4 times
Dismiss option is selected from the Commands Menu to return to the **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Management Information Systems"
Use of the Scroll Bars to view the content of the document
Next is used 3 times
Previous
Matching Image Page option is selected from the View Menu : **Image Window** opens
Next
Previous is used 4 times
Next
Go To Page option is selected from the Commands Menu to reach a further image page
This image page is the ELINOR Contents Page
Scroll Bars
Previous
Scroll Bars
Previous is used 5 times
Scroll Bars
Previous is used twice
Scroll Bars
Previous
Go To Page option is selected from the Commands Menu to reach a further image page
Scroll Bars
Go To Page option is selected from the Commands Menu to reach a further image page
Scroll Bars
Go To Page option is selected from the Commands Menu to reach a further image page
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Developing Information Systems"
Scroll Bars
Go To Page option is selected from the Commands Menu to reach a further image page and used twice
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page
Scroll Bars
Go To Page option is selected from the Commands Menu to reach a further image page
Scroll Bars
Next is used twice
Scroll Bars
Next is used twice
Dismiss option is selected from the Commands Menu to return to the previous image window
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Developing Information Systems"
Scroll Bars
Go To Page option is selected from the Commands Menu to reach a further text page
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens

The document is entitled "Information Systems Management"
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page and used twice
Next is used 4 times
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Information Systems Methodologies"
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page and used twice
Scroll Bars
Next
Scroll Bars
Next
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Management of Systems Development"
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page and used twice
Next is used 4 times
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "FISD 1993 - 1994"
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
The same document "FISD 1993 - 1994" is selected from the hit list by double clicking with the mouse : **Text Window** opens
Next
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "Advanced Information for Diagnostics"
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page and used twice
Scroll Bars
Next
Scroll Bars
Next
Dismiss option is selected from the Commands Menu to return to **Text Window**
Scroll Bars
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens
The document is entitled "MSc IT Student Handbook Sept 1994"
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page and used 3 times
Next
Dismiss option is selected from the Commands Menu to return to the previous image page
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**
A document in the hit list is selected by double clicking with the mouse : **Text Window** opens

The document is entitled "SPE 1993 Vol 23 No 6"
Go To Page option is selected from the Commands Menu to reach a further text page
Matching Image Page option is selected from the View Menu : **Image Window** opens
Go To Page option is selected from the Commands Menu to reach a further image page
Scroll Bars
Next
Previous is used twice
Go To Page option is selected from the Commands Menu to reach a further image page
Dismiss option is selected from the Commands Menu to return to the previous image page
Dismiss option is selected from the Commands Menu to return to **Text Window**
Dismiss option is selected from the Commands Menu to return to **Search Window**

Details of each operational facility used were transferred to a spreadsheet for ease of reference, a separate spreadsheet being created for each task and student. By this method the total number and nature of operational facilities used could be clearly seen. Figure E1 illustrates the spreadsheet created to record the operational facilities used by Student 125 in Task 1. Each facility used is indicated by a cross.

Figure E1
An Illustration Of The Spreadsheet For Recording The Operational Facilities Used By Student 125 In Task 1

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Control Window** | | **Fileroom Window** | | **Search Window** | | cont | | cont | |
| | | | | | | | | | |
| Document Icon | | Fileroom Icon | | *Commands Menu* | | *View Menu* | | Double Click to TW | X |
| Fileroom Icon | | Cabinet | | Content Search | | Text Page | | Double Click to Doct Window | |
| Search Icon | X | Drawer | | Label Search | | Image Page | | Content Search by Default | X |
| Exit Icon | | Folder | | Control Search | | Document | | | |
| | | Document | | Clear Hit List | X | Fileroom | | | |
| | | In basket Icon | | Rate | | | | | |
| | | Waste basket Icon | | Previous Hit | | *Customize Menu* | | | |
| | | | | Next Hit | | Search Parameters | | | |
| | | *Commands Menu* | | Launch Text | | Save Geometry | | | |
| | | Dismiss | | Launch Image | | | | | |
| | | | | Save Hit List | | Content Button | | | |
| | | *Customize Menu* | | Restore Hit List | | Label Button | | | |
| | | Save Geometry | | Latest Thesaurus Clue | | Control Button | | | |
| | | | | Dismiss | X | Dismiss Button | | | |
| | | Dismiss Button | | | | Text Button | | | |
| | | | | *Edit Menu* | | Image Button | | | |
| | | | | Paste | | Rate Button | | | |
| | | | | | | Limit Option | | | |
| | | | | | | | | | |
| **Document Window** | | **Text Window** | | **Image Window** | | | | | |
| | | | | | | | | | |
| *Commands Menu* | | *Commands Menu* | | *Commands Menu* | | | | | |
| Close | | Go To Page | X | Go To Page | X | | | | |
| Document Control | | Print Whole Document | | Print Whole Document | | | | | |
| Export Document | | Print This Page | | Print This Page | | | | | |
| Launch Image | | Remote Printer Selection | | Remote Printer Selection | | | | | |
| Launch Text | | Local Print | | Local Print | | | | | |
| Dismiss | | Local Print Setup | | Local Print Setup | | | | | |
| | | Launch Match Image Page | | Launch Match Text Page | | | | | |
| *View Menu* | | Launch Text Page | | Launch Image | | | | | |
| Text Page | | Dismiss | X | Dismiss | X | | | | |
| Image Page | | | | | | | | | |
| Fileroom | | *Edit Menu* | | Next! | X | | | | |
| | | Copy | | Previous! | X | | | | |
| *Customize Menu* | | Copy Document Page | | | | | | | |
| Document Parameters | | | | *View Menu* | | | | | |
| Save Geometry | | Next! | X | Matching Text Page | | | | | |
| | | Previous! | X | Document | | | | | |
| Text Button | | | | Fileroom | | | | | |
| Image Button | | *View Menu* | | | | | | | |
| File Button | | Matching Image Page | X | *Customize Menu* | | | | | |
| Dismiss Button | X | Document | X | Image Parameters | | | | | |
| Close Button | | Fileroom | | Arrows | | | | | |
| Document Control Button | | | | Angle Box | | | | | |
| | | *Customize Menu* | | Scale Box | | | | | |
| Double Click to IW | | Text Parameters | X | Lock | | | | | |
| Double Click to TW | | Lock | | Show Scale Bar | | | | | |
| | | Save Geometry | | Save Geometry | | | | | |
| | | | | | | | | | |
| | | | | Pans with Mouse | | | | | |

Details of each document used were also transferred to a spreadsheet. In contrast to the method used for recording operational facilities, only one spreadsheet was created to record the details of the documents used by each student in each task. Figure E2 depicts a cross section of this spreadsheet. The cross section shows details of the documents used by five students, including Student 125. A key was used to identify the nature of each document used by the students. For example, in Figure E2, the letter B is used to identify the document as a book; the letters EP are used to identify the document as an exam paper; the letter J denotes a journal; LN identifies Lecture Notes; and H denotes Handbooks. The letter O is used to identify "other" documents which appear in ELINOR's in-box, but have yet to be allocated a place within the Fileroom (Section 2.3.2).

Figure E2
A Cross Section Of The Spreadsheet Recording The Number and Nature of Documents Used By Students In Each Task

| Student | Title of Document | Type | Title of Document | Type | Title of Document | Type |
|---|---|---|---|---|---|---|
| 111 | Expert Systems : Tools and Applications | B | BIS Yr 2 1993 Exam Paper | EP | Prototyping | O |
| | | | | | Developing Information Systems | B |
| 116 | Expert Systems : Tools and Applications | B | BIS Yr 2 1993 Exam Paper | EP | Prototyping | O |
| | | | | | Developing Information Systems | B |
| | | | | | Project Management for Info Systems | B |
| | | | | | Introducing Systems Design | B |
| | | | | | Understanding Information | B |
| | | | | | Developing Computer Programmes | B |
| | | | | | Management of Systems Development | B |
| | | | | | Brewing for Profit or Consumer Loyalty | B |
| | | | | | Project Arrangement for Information Systems | B |
| 125 | Expert Systems : Tools and Applications | B | BIS Yr 2 1993 Exam Paper | EP | Prototyping | O |
| | | | | | Management Information Systems | B |
| | | | | | Developing Information Systems | B |
| | | | | | Information Systems Management | B |
| | | | | | Information Systems Methodologies | B |
| | | | | | Management of Systems Development | B |
| | | | | | FISD 1993 - 1994 | J |
| | | | | | Advanced Information for Diagnostics | B |
| | | | | | MSC IT Student Handbook | H |
| | | | | | SPE 1993 Vol 23 No. 6 | J |
| 144 | Expert Systems : Tools and Applications | B | BIS Year 2 1993 Exam Paper | EP | Prototyping | O |
| | ELINOR Documents | O | | | | |
| 175 | Expert Systems : Tools and Applications | B | BIS Yr 2 1993 Exam Paper | EP | Prototyping | O |
| | | | | | Information Systems Methodologies | B |
| | | | | | Intro to Soft Systems Methodologies | B |
| | | | | | Systems Theory Lecture | LN |
| | | | | | Management Information Systems | B |

Details of the number and nature of both documents and operational facilities used by each student were transferred to a further spreadsheet for ease of reference. Figure E3 shows a cross section of this spreadsheet. The number of operational facilities used refers to the total number of different facilities used. For the purposes of this research all operational facilities are considered to be different from one another. The number and nature, or range, of operational facilities used will therefore be the same (Section 5.4).

Figure E3
A Section Of The Spreadsheet Recording The Number And Nature Of Both Documents And Operational Facilities Used By Each Student In Each Task

| Student | Learning | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Style | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 111 | T | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 116 | A | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | R | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 144 | A | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 175 | A | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |

From the data in Figure E3, the patterns of information retrieval for five students can be clearly seen. Analysis of differences in the number and nature of documents and operational facilities used by each learning style group is discussed in Section 8.1.

# APPENDIX F

## The Evaluation Questionnaire

An evaluation questionnaire was used in recording the attitudes of students regarding the extent to which they were constrained by ELINOR's functionality. Problems encountered regarding students' responses to the questionnaire led to a number of changes in its design.

The three versions of the evaluation questionnaire appear in Appendices F.1, F.2 and F.3, respectively. The show card for use with the third version of the questionnaire is also contained in Appendix F.3.

# F.1 The Evaluation Questionnaire: Version 1

Control No. [ ]

**ELINOR EVALUATION QUESTIONNAIRE**

1. Describe ELINOR on the scales below by circling the number that most closely corresponds to the system.

| | | | | | | |
|---|---|---|---|---|---|---|
| Challenging | 1 | 2 | 3 | 4 | 5 | Uninspiring |
| Innovative | 1 | 2 | 3 | 4 | 5 | Ordinary |
| Constraining | 1 | 2 | 3 | 4 | 5 | Unconstraining |
| Useful | 1 | 2 | 3 | 4 | 5 | Little practical use |
| Interesting | 1 | 2 | 3 | 4 | 5 | Boring |
| Methodical | 1 | 2 | 3 | 4 | 5 | Unstructured |

2. Please indicate how much you agree or disagree with the following statements by placing a tick in the appropriate boxes.

a) I was able to complete the tasks to my satisfaction.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

b) I felt comfortable with the way in which ELINOR allowed me to approach the tasks.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

3. **For each task in turn**, please indicate if ELINOR should contain more documents (ring **M**), the same number of documents (ring **S**) or fewer documents (ring **F**). If you do not know the answer or feel that it is irrelevant to the task, ring **D** (for don't know).

| | Task 1 | Task 2 | Task 3 |
|---|---|---|---|
| Books | M S F D | M S F D | M S F D |
| Course Materials : | | | |
| Exam papers | M S F D | M S F D | M S F D |
| Handbooks | M S F D | M S F D | M S F D |
| Lecture Notes | M S F D | M S F D | M S F D |
| Study Guides | M S F D | M S F D | M S F D |
| Syllabi | M S F D | M S F D | M S F D |
| Journals | M S F D | M S F D | M S F D |
| Library In-house Collection | M S F D | M S F D | M S F D |
| Staff Publications | M S F D | M S F D | M S F D |
| Student Projects | M S F D | M S F D | M S F D |

**Please turn over**

4. a) In performing the tasks would you have preferred the number of operational facilities provided by ELINOR to be : (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, describe any additional operational facilities which you feel ELINOR should provide.

Task 1 ..........................................................................................................

..........................................................................................................

Task 2 ..........................................................................................................

..........................................................................................................

Task 3 ..........................................................................................................

..........................................................................................................

c) If fewer, describe any operational facilities which you feel should be excluded or were not useful.

Task 1 ..........................................................................................................

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Task 2 ..........................................................................................................

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Task 3 ..........................................................................................................

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5. a) Were there any other aspects of ELINOR which constrained your approach to the tasks. (Please indicate to which task(s) your comment(s) refer).

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b) Have you any suggestions for improving these aspects ?

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<u>Thank you for your co-operation in completing this questionnaire.</u>

## F.2 The Evaluation Questionnaire: Version 2

Control No. [ ]

**ELINOR EVALUATION QUESTIONNAIRE**

1. Describe ELINOR on the scales below by circling the number that most closely corresponds to the system.

| | | | | | | |
|---|---|---|---|---|---|---|
| Challenging | 1 | 2 | 3 | 4 | 5 | Uninspiring |
| Innovative | 1 | 2 | 3 | 4 | 5 | Ordinary |
| Constraining | 1 | 2 | 3 | 4 | 5 | Unconstraining |
| Useful | 1 | 2 | 3 | 4 | 5 | Little practical use |
| Interesting | 1 | 2 | 3 | 4 | 5 | Boring |
| Methodical | 1 | 2 | 3 | 4 | 5 | Unstructured |

2. Please indicate how much you agree or disagree with the following statements by placing a tick in the appropriate boxes.

a) I was able to complete the tasks to my satisfaction.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

b) I felt comfortable with the way in which ELINOR allowed me to approach the tasks.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

3. **For each task in turn**, please indicate if the number of documents within ELINOR should change. If you think there should be more documents, ring **M**. If you think there should be the same number of documents, ring **S**. If you think there should be fewer documents, ring **F**. **You may feel that some types of document are irrelevant to the task. In this case, ring I.**

| | Task 1 | Task 2 | Task 3 |
|---|---|---|---|
| Books | M S F I | M S F I | M S F I |
| Course Materials : | | | |
| Exam papers | M S F I | M S F I | M S F I |
| Handbooks | M S F I | M S F I | M S F I |
| Lecture Notes | M S F I | M S F I | M S F I |
| Study Guides | M S F I | M S F I | M S F I |
| Syllabi | M S F I | M S F I | M S F I |
| Journals | M S F I | M S F I | M S F I |
| Library In-house Collection | M S F I | M S F I | M S F I |
| Staff Publications | M S F I | M S F I | M S F I |
| Student Projects | M S F I | M S F I | M S F I |

**Please turn over**

4. a) In performing the tasks would you have preferred the number of operational facilities provided by ELINOR to be : (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, describe any additional operational facilities which you feel ELINOR should provide.

Task 1 ......................................................................................................

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Task 2 ......................................................................................................

......................................................................................................

Task 3 ......................................................................................................

......................................................................................................

c) If fewer, describe any operational facilities which you feel should be excluded or were not useful.

Task 1 ......................................................................................................

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Task 2 ......................................................................................................

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Task 3 ......................................................................................................

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5. a) Were there any other aspects of ELINOR which constrained your approach to the tasks. (Please indicate to which task(s) your comment(s) refer).

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b) Have you any suggestions for improving these aspects ?

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Thank you for your co-operation in completing this questionnaire.

## F.3 The Evaluation Questionnaire: Version 3

Control No. [ ]

**ELINOR EVALUATION QUESTIONNAIRE**

1. Describe ELINOR on the scales below by circling the number that most closely corresponds to the system.

| | | | | | | |
|---|---|---|---|---|---|---|
| Challenging | 1 | 2 | 3 | 4 | 5 | Uninspiring |
| Innovative | 1 | 2 | 3 | 4 | 5 | Ordinary |
| Constraining | 1 | 2 | 3 | 4 | 5 | Unconstraining |
| Useful | 1 | 2 | 3 | 4 | 5 | Little practical use |
| Interesting | 1 | 2 | 3 | 4 | 5 | Boring |
| Methodical | 1 | 2 | 3 | 4 | 5 | Unstructured |

2. Please indicate how much you agree or disagree with the following statements by placing a tick in the appropriate boxes.

a) I was able to complete the tasks to my satisfaction.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

b) I felt comfortable with the way in which ELINOR allowed me to approach the tasks.

| | Agree Strongly | Agree | Neither Agree Nor Disagree | Disagree | Disagree Strongly |
|---|---|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] | [ ] | [ ] |

3. a) **In order to complete each task** would you have preferred the number of documents provided by ELINOR to be : (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, which documents should ELINOR provide more of ? (Please refer to the list provided)

Task 1 ..........................................................................................................

Task 2 ..........................................................................................................

Task 3 ..........................................................................................................

c) If fewer, which documents should ELINOR provide less of ? (Please refer to the list provided)

Task 1 ..........................................................................................................

Task 2 ..........................................................................................................

Task 3 ..........................................................................................................

**Please turn over**

4. a) In performing the tasks would you have preferred the number of operational facilities provided by ELINOR to be : (Please tick the appropriate boxes)

| | Greater | The Same | Fewer |
|---|---|---|---|
| Task 1 | [ ] | [ ] | [ ] |
| Task 2 | [ ] | [ ] | [ ] |
| Task 3 | [ ] | [ ] | [ ] |

b) If greater, describe any additional operational facilities which you feel ELINOR should provide.

Task 1 ..............................................................................................................

..............................................................................................................

Task 2 ..............................................................................................................

..............................................................................................................

Task 3 ..............................................................................................................

..............................................................................................................

c) If fewer, describe any operational facilities which you feel should be excluded or were not useful.

Task 1 ..............................................................................................................

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Task 2 ..............................................................................................................

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Task 3 ..............................................................................................................

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5. a) Were there any other aspects of ELINOR which constrained your approach to the tasks. (Please indicate to which task(s) your comment(s) refer).

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b) Have you any suggestions for improving these aspects ?

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Thank you for your co-operation in completing this questionnaire.

*Document Types contained within ELINOR :*

Books

Journals

Library In-house Collection

Staff Publications

Course Materials :

- Exam papers
- Handbooks
- Lecture Notes
- Study Guides
- Syllabi
- Student Project Reports

# APPENDIX G

## The Interviews

## G.1 Introduction

Interviews were undertaken with each student in the research sample following completion of the training programme, tasks and evaluation questionnaire. Measures were taken to ensure each of these aspects was appropriate for the research (Sections 6.6, 6.7 and 6.8.2). However, the interviews provided a further opportunity for validation by gaining an insight into the attitudes of students towards each activity. The interviews also provided the opportunity to gain additional information regarding ELINOR's ability to support the information retrieval activities of students, supplementing the data provided by the evaluation questionnaire. This was particularly beneficial as a number of students did not respond to the questionnaire as required (Section 7.2.2). The interviews were conducted in an informal manner. However, consistency was maintained in the nature and order of questions to prevent bias.

Completion of the training programme, tasks and evaluation questionnaire took between one and two hours. Therefore, the time taken to conduct the interviews was kept to a minimum. The exercise was used to gain a general, rather than detailed, indication of students' attitudes. Open-ended questions were used, allowing students to express their opinions without leading them towards any particular issue or response. If students experienced problems with the training programme and/or evaluation questionnaire but were unsure of the reason why, they were asked a number of questions to ascertain if the problem resulted from inappropriate design. This information is of particular importance in both assessing the suitability of each aspect for the present research, and in making improvements for future research.

Sections G.2 to G.5 detail the questions asked in gaining attitudes regarding the training programme, tasks and evaluation questionnaire. Examples of responses given by students are also provided to illustrate the way in which the required information was elicited from each student.

## G.2 Gaining Attitudes Towards The Training Programme

Students were asked the following question with regard to the training programme.

1. Can you tell me what you thought of the training programme?

If students experienced problems with the training programme but were unsure of the reason why, they were asked Questions 2 and 3 to ascertain if the difficulty arose from the design of the training programme.

2. Was the training programme clear and easy to understand?
3. Was the content of the training programme sufficient for gaining the information needed to perform the tasks?

Question 4 was asked to gain an insight into how any previously stated problems might be overcome. The question was also asked of students who had not experienced any problems. This provided insight into the way in which the programme could be improved further, allowing enhancement of its suitability for further research.

4. Is there any way in which you think the training programme may be improved?

Example:

Q *Can you tell me what you thought about the training programme?*

A *The training programme was quite good. It provided the right information but was a little repetitive. For example, use of the scroll bar is explained several times in different sections of the programme.*

This response indicates that the training programme is clear and provides sufficient information for performing the tasks, even though it is repetitive. The student was then asked how the training programme could be improved further.

Q *Is there any way in which the training programme could be improved?*

A *Do not repeat how to use the scroll bar. Also, where the programme instructs students to practice using a command, the instructions are underlined. However, a description of what the student should see having used this command is also underlined. Perhaps the underlining should be for the instructions only.*

## G.3 Gaining Attitudes Towards The Tasks

Students were asked the following question with regard to the tasks.

1. How did you get on with the tasks?

Students were asked to respond taking each task in turn. Where students clearly found difficulty with the tasks but did not know the reason why, they were asked a number of questions to ascertain whether their difficulty arose from the design of the tasks or from ELINOR's functionality. These questions were:

2. Did you understand what you were being asked to do?
3. Did you understand the wording used in the tasks?
4. Did ELINOR allow you to complete the tasks in the way you wanted?

The following question was asked in order to determine how any problems might be resolved:

5. Is there any way in which these problems might be overcome?

If any problems arose from ELINOR's operational facilities or document content, the response to Question 5 provided an indication of the functionality required to facilitate the information retrieval activities of the students. This information was used to supplement the information gained from the evaluation questionnaire. If any problems resulted from the way in which the tasks had been designed, then the response would help in improving the tasks for future research.

Example:

Q *How did you get on with the tasks?*

A *Task 1 was very simple to do. In Task 2, I tried using the Fileroom. However I got confused as all the exam papers for that course and year were put together in one document. This meant you had to go through each page to find the right exam paper. I then tried looking for the exam paper using Search. This was a lot easier.*

The response indicates that ELINOR does not support this student's information retrieval activities in Task 2. However, the problem does not arise from the design of the tasks or ELINOR's functionality. The problem results from the way in which the document has been written. The student was asked the same question with regard to Task 3 as the response had not mentioned this task previously.

Q *How did you get on with Task 3?*

A *For Task 3, course material is not needed in order to find the answer so it would be handy to specify the type of document you are looking for when searching so only relevant types of document are retrieved. When accessing the pages giving a summary of the document (the ELINOR Contents Pages) it would be useful to give other information which you could turn on, for example, the year the book was published. However, it is fairly simple to get to this information otherwise.*

The response regarding Task 3 indicates the need for additional operational facilities. These include a facility allowing a search to be conducted using only certain document types and; a facility providing bibliographic information.

The student is clear that the difficulties encountered arise from the way in which documents have been written and ELINOR's functionality. The student has not indicated an inability to understand what is required from the tasks. Therefore, the design of each task is appropriate.

Q *Is there any way in which these problems could be overcome?*

The student has already indicated how the problems encountered in Task 3 may be overcome. With regard to Task 2 the following answer was given.

A *If you use Search it is OK, otherwise have each exam paper in a separate document.*

## G.4 Gaining Attitudes Towards The Evaluation Questionnaire

Students were asked the following question with regard to the evaluation questionnaire.

1. What are your views regarding the evaluation questionnaire?

If students indicated that they found the questionnaire difficult to complete, they were asked to state the reason why. If they were unsure of this, they were asked the following questions to ascertain if the difficulty arose from the design of the questionnaire.

2. Did the instructions provide sufficient information for answering the questionnaire?
3. Was the wording used clear and easy to understand?
4. Was it clear where answers should be placed?
5. Was sufficient space provided for answering each question?

Question 6 was asked to gain an insight into how any problems may be overcome. Where no problems were experienced, it provided insight into the way in which the questionnaire could be improved further. This information is useful for enhancing the suitability of the questionnaire for further research.

6. Is there any way in which you think the questionnaire may be improved?

Example:

Q *What are your views regarding the evaluation questionnaire?*

A *Its design allows for all the comments you need to make about ELINOR. Where questions provide several categories for your answer, for example, agree and agree strongly etc., it was hard to decide between them, so I went for the middle option. I had no other difficulties with the questionnaire and can think of no way in which it could be improved.*

These comments indicate that it is beneficial to provide a middle option for those who have no strong attitude regarding the issues dealt with in the questionnaire.

Question 3 of the evaluation questionnaire asks students to indicate their preferences regarding the number of documents provided by ELINOR and, where applicable, to which document types their answer relates. Students were required to respond taking each task in turn. However, a number of students did not respond to this question as intended (Section 7.2.2). Where the response indicated that the question may have been misinterpreted, students were asked to clarify their answer. Therefore students were asked the following question.

7. Can you explain your answer to Question 3?

A variety of responses were given to this question including the following.

> *"The more information ELINOR contains, the better".*
>
> *"I would have preferred more exam papers for Task 2, not to do the question, but as a general issue in order to help people revise".*

These responses indicate that students omitted to answer the question as required. They have considered the document content of ELINOR in general terms, rather than in relation to each task. Therefore, conclusions regarding the extent to which ELINOR's document content constrains the information retrieval activities of each learning style group in each task must be interpreted with care.

Section G.5 summarises the responses given by each student during the interviews.

## G.5 A Summary Of The Interview Responses

### G.5.1 Training Programme

Overall, the interviews indicated that the training programme was easy to understand, clear and thorough. However, a number of suggestions for further improvement were made. These are described below.

- Several facilities are common to both the Text and Image Windows. An explanation of these facilities was provided within both sections relating to the Text Window and the Image Window. This seemed rather repetitive and unnecessary to some students and it was suggested that the explanation should appear in one section only. However, in addition to providing instruction in the use of ELINOR, the training programme was designed as a reference tool for use during the tasks. Including an explanation of each facility within sections relating to both the Text and Image Windows allows relevant information to be gained about each window quickly and easily, without having to refer to any other section.

- One student suggested that a flow diagram showing the relationship of each window to other windows would be useful to assist students in gaining an overview of ELINOR.

- It was suggested that examples similar to the tasks should be included, showing how to search for specific documents and authors. However, use of examples similar to the tasks was not feasible. Examples of all three tasks would have to be included in order to prevent bias. Every possible method of performing the tasks would also have to be included to give choice in the process by which the tasks were completed. Telling students how to search in one particular way would bias results regarding the effect of learning style on search behaviour. These factors would also have made the training programme too lengthy.

- Several students observed that a number of ELINOR's operational facilities were not explained in the training programme. As explained in Section 6.6, an explanation of ELINOR's entire range of operations would have been a lengthy process, possibly requiring more than one training session for sufficient knowledge to be gained. This was not feasible within the present research. The objective of the training was to ensure familiarity with the fundamental elements of ELINOR needed to perform the tasks. The training programme explained that additional operations were available if students wished to use them.

- Care was taken to ensure the terminology used within the training programme was clear and unambiguous. Even though all the students in the sample were undertaking computing courses, extensive and unnecessary use of computing terminology was avoided. Students were also given the opportunity to ask for help regarding any aspect of the programme which they did not understand. The terminology presented no problems to the sample of students. However, one student was concerned that terms such as "minimising" may be a problem if the programme were to be used in training those undertaking different courses who may not be familiar with computers.

- One student observed that the amount of information provided by the training programme was a lot to understand in one instance. The fact that students were able to refer to the training programme during the tasks was therefore appreciated.

- It was suggested that perhaps the training programme could have been given to students when they were first contacted regarding participation in the research, allowing them to study it beforehand. This may have enabled students to achieve greater familiarity with ELINOR. However, the amount of time spent in studying the programme may vary between students resulting in differing levels of knowledge. Requiring students to work through the training programme prior to the tasks ensured each student was given a similar amount of time in which to study the programme. The programme was designed to be interactive, providing opportunities for students to use each facility in order to illustrate its function and aid understanding. Access to ELINOR is therefore required for completion of the training programme. This access was not available to students prior to their participation.

### G.5.2 Tasks

- Several students found one or more of the tasks to be "difficult" or "confusing". When asked to state the reason for this, students indicated that the difficulty resulted from ELINOR's functionality rather than the task itself. When asked how this problem could be overcome, the majority of students repeated the comments they had given in response to the evaluation questionnaire. They described additional documents and/or facilities which would be beneficial. Some gave additional detail providing further clarification of any problems found.

### G.5.3 Evaluation Questionnaire

- The majority of students found the evaluation questionnaire clear and easy to understand. Only one comment was made about its design. This related to the options given for response and is shown in the example provided in Section G.4.

- When asked to clarify responses to Question 3, it was clear that the majority of students had omitted to relate their answers to the tasks. A number of students stated that they would prefer more documents in order to answer Tasks 1 and/or 2. This response seems irrational as Tasks 1 and 2 require students to find one, specific document. When asked to give a reason for their answer, students indicated that the more information there is contained within ELINOR, the better. This indicates that the students' response relates to ELINOR in general rather than to the tasks. One student indicated they would have preferred more documents for Task 1 because the information required by the question (i.e. the author's name) might be in different areas within different books, and finding the author in different books would give greater experience in retrieving information of this kind. Another student stated that they would like different editions of the same book. With regard to Task 2 some students stated that their answer referred to the fact that they would like each exam paper to be contained within a separate document rather than in one large document.

# APPENDIX H

## Analysis Of Search Experience And Computer Literacy

## H.1 Introduction

A weighting mechanism was used to identify groupings within the data regarding the level of search experience and computer literacy held by students. As described in Section 8.3, search experience was determined by the frequency with which a number of information sources were used. These comprised OPAC, CD ROM, the Internet and paper sources (for example, books and journals). Computer literacy was determined by the frequency with which word processing, spreadsheet, database and graphics applications were used. Separate analyses were undertaken for information sources and computer applications using the method described in Section H.2.

## H.2 Analysis Of Search Experience And Computer Literacy

Weights were allocated on the basis of whether an information source or computer application was used always, sometimes, rarely or never. Thus a score could be given to each student for the frequency with which each source or application was used. A total score for the use of information sources or computer applications was then obtained by adding together the scores for each individual source or application. The following example illustrates the process used in calculating the total score for use of computer applications for one student.

Example:

Student 8 has indicated that a word processor is always used, spreadsheets and databases are sometimes used, but graphics packages are used very rarely. The weights allocated for the frequency of use are as follows:

| | |
|---|---|
| Always | 500 |
| Sometimes | 250 |
| Rarely | 125 |
| Never | 50 |

Scores for the use of each individual computer application were allocated on the basis of these weights. Thus, Student 8 has a score of 500 for use of the word processor; 250 for the use of spreadsheets; 250 for databases and 125 for graphics packages. This information is summarised in Table H1. A total score for all applications was gained by calculating the sum of the scores for individual applications. This is also shown in Table H1.

Table H1
Calculating A Score For The Use Of Various Computer Applications

| Student | Frequency Of Use | | | | Weighted Score For The Use Of Each Application | | | | Total Score |
|---|---|---|---|---|---|---|---|---|---|
| | WP | SS | DB | GP | WP | SS | DB | GP | |
| 8 | A | S | S | R | 500 | 250 | 250 | 125 | 1125 |

Three equal bands were established which correspond to the upper, middle and lower portions of the range of possible scores between nought and the maximum score. The maximum score results from responding "always" to the frequency with which each information source or computer application is used. The bands were labelled low, moderate and high, respectively. In this example, the maximum score is 2000. The bands are as follows:

| | |
|---|---|
| Low | 1 - 667 |
| Moderate | 168 - 1333 |
| High | 1334 - 2000 |

The scores for each student may be compared with these bands in order to determine the level of computer literacy displayed by each student. In the example above, Student 8 would be classed as having a moderate level of computer literacy as a score of 1125 (Table H1) falls within this band.

Five different sets of weights were employed to ascertain whether the value of the weights used influenced the categorisation of students within the bands. No influence from different weighting mechanisms was found. The different weights used are given in Table H2.

Table H2
Weights Used During The Analysis Of Search Experience And Computer Literacy

| Always | Sometimes | Rarely | Never |
|---|---|---|---|
| 500 | 250 | 125 | 50 |
| 200 | 100 | 50 | 25 |
| 100 | 50 | 25 | 10 |
| 40 | 20 | 10 | 5 |
| 10 | 6 | 3 | 1 |

# APPENDIX I

## Raw Data

Appendix I.1 contains raw data for the number and nature of documents and operational facilities used. Appendix I.2 contains raw data for the number of times use was made of the Search and Fileroom facilities. Appendix I.3 contains raw data for constraint by ELINOR's document content and operational facilities. Instances in which students could not be classified as constrained by ELINOR's document content and/or operational facilities are identified by a question mark.

In each of Appendices I.1, I.2 and I.3, the following key applies.

| | | | |
|---|---|---|---|
| Learning Style | A = Activists<br>R = Reflectors<br>T = Theorists<br>P = Pragmatists | Computer Affinity | H = High<br>M = Moderate<br>L = Low |
| Gender | F = Females<br>M = Males | Computer Literacy | H = High<br>M = Moderate<br>L = Low |
| Ethnic Origin | A = Asians<br>E = Europeans<br>O = Other (Africans) | Search Experience | H = High<br>M = Moderate<br>L = Low |
| Social Class | 1 = Class 1<br>2 = Class 2<br>3 = Class 3<br>4 = Class 4 | | |

## I.1 Raw Data For The Number And Nature Of Documents And Operational Facilities Used

Table I1
Learning Style

| Student | Learning Style | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 32 | A | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |
| 39 | A | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 52 | A | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 60 | A | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 82 | A | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 85 | A | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 92 | A | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 116 | A | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 144 | A | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 175 | A | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 208 | A | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 244 | A | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 323 | A | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 341 | A | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 361 | A | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |
| 383 | A | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 398 | A | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 413 | A | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 430 | A | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |
| 46 | P | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 199 | P | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 228 | P | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 290 | P | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 374 | P | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 377 | P | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 8 | R | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 41 | R | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 47 | R | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 71 | R | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 125 | R | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 192 | R | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 201 | R | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 263 | R | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 284 | R | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | R | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 324 | R | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 380 | R | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 382 | R | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 395 | R | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 434 | R | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |
| 445 | R | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 10 | T | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 111 | T | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 224 | T | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 233 | T | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 287 | T | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 335 | T | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 346 | T | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 352 | T | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 365 | T | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 370 | T | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 386 | T | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 388 | T | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |

## Table I2
## Gender

| Student | Gender | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | F | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 10 | F | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 32 | F | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |
| 39 | F | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 41 | F | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 144 | F | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 224 | F | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 263 | F | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 324 | F | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 346 | F | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 361 | F | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |
| 388 | F | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |
| 395 | F | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 413 | F | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 434 | F | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |
| 445 | F | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 46 | M | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 47 | M | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 52 | M | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 60 | M | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 71 | M | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 82 | M | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 85 | M | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 92 | M | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 111 | M | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 116 | M | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | M | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 175 | M | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 192 | M | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 199 | M | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 201 | M | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 208 | M | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 228 | M | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 233 | M | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 244 | M | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 284 | M | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | M | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 287 | M | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 290 | M | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 323 | M | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 335 | M | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 341 | M | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 352 | M | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 365 | M | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 370 | M | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 374 | M | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 377 | M | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 380 | M | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 382 | M | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 383 | M | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 386 | M | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 398 | M | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 430 | M | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |

# Table I3
## Ethnic Origin

| Student | Ethnic Origin | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | A | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 10 | A | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 32 | A | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |
| 41 | A | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 46 | A | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 52 | A | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 85 | A | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 92 | A | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 111 | A | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 192 | A | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 208 | A | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 224 | A | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 228 | A | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 287 | A | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 335 | A | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 361 | A | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |
| 365 | A | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 395 | A | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 413 | A | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 39 | E | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 47 | E | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 60 | E | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 71 | E | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 82 | E | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 116 | E | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | E | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 144 | E | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 175 | E | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 199 | E | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 201 | E | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 233 | E | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 244 | E | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 263 | E | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 284 | E | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | E | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 290 | E | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 323 | E | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 324 | E | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 341 | E | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 346 | E | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 352 | E | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 370 | E | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 374 | E | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 377 | E | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 380 | E | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 382 | E | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 383 | E | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 386 | E | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 398 | E | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 430 | E | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |
| 434 | E | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |
| 445 | E | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 388 | O | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |

# Table I4
# Social Class

| Student | Social Class | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | 1 | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 41 | 1 | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 47 | 1 | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 71 | 1 | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 144 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 201 | 1 | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 228 | 1 | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 244 | 1 | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 386 | 1 | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 445 | 1 | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 39 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 46 | 2 | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 52 | 2 | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 60 | 2 | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 82 | 2 | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 85 | 2 | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 92 | 2 | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 116 | 2 | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | 2 | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 175 | 2 | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 199 | 2 | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 208 | 2 | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 224 | 2 | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 233 | 2 | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 284 | 2 | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | 2 | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 323 | 2 | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 341 | 2 | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 370 | 2 | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 374 | 2 | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 382 | 2 | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 383 | 2 | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 413 | 2 | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 430 | 2 | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |
| 32 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |
| 111 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 192 | 3 | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 263 | 3 | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 287 | 3 | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 290 | 3 | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 324 | 3 | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 335 | 3 | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 346 | 3 | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 352 | 3 | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 365 | 3 | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 377 | 3 | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 380 | 3 | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 388 | 3 | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |
| 395 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 398 | 3 | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 434 | 3 | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |
| 10 | 4 | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 361 | 4 | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |

## Table I5
## Computer Affinity

| Student | Computer Affinity | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | H | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 10 | H | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 41 | H | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 46 | H | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 47 | H | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 52 | H | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 60 | H | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 71 | H | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 82 | H | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 92 | H | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 111 | H | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 116 | H | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | H | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 175 | H | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 192 | H | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 199 | H | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 201 | H | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 208 | H | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 224 | H | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 228 | H | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 233 | H | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 244 | H | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 263 | H | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 284 | H | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | H | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 287 | H | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 290 | H | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 323 | H | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 324 | H | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 335 | H | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 341 | H | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 346 | H | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 352 | H | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 361 | H | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |
| 370 | H | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 374 | H | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 377 | H | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 380 | H | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 382 | H | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 383 | H | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 386 | H | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 395 | H | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 398 | H | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 413 | H | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 430 | H | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |
| 445 | H | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 39 | M | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 85 | M | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 144 | M | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 388 | M | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |
| 32 | L | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |
| 365 | L | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 434 | L | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |

Table I6
Computer Literacy

| Student | Computer Literacy | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 10 | H | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 41 | H | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 46 | H | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 52 | H | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 71 | H | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 85 | H | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 92 | H | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 111 | H | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 116 | H | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | H | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 192 | H | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 233 | H | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 284 | H | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | H | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 323 | H | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 335 | H | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 341 | H | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 346 | H | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 352 | H | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 361 | H | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |
| 382 | H | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 386 | H | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 430 | H | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |
| 445 | H | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 8 | M | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 39 | M | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 47 | M | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 60 | M | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 82 | M | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 144 | M | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 175 | M | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 199 | M | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 201 | M | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 208 | M | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 224 | M | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 228 | M | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 244 | M | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 263 | M | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 287 | M | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 290 | M | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 324 | M | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 365 | M | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 370 | M | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 374 | M | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 377 | M | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 380 | M | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 383 | M | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 388 | M | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |
| 395 | M | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 398 | M | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 413 | M | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 434 | M | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |
| 32 | L | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |

# Table I7
## Search Experience

| Student | Search Experience | No. of Documents Used | | | No. of Document Types Used | | | No. and Nature of Facilities Used | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 41 | H | 2 | 2 | 4 | 2 | 1 | 2 | 38 | 12 | 44 |
| 71 | H | 1 | 1 | 2 | 1 | 1 | 2 | 12 | 6 | 18 |
| 111 | H | 1 | 1 | 2 | 1 | 1 | 2 | 23 | 6 | 22 |
| 201 | H | 1 | 1 | 13 | 1 | 1 | 4 | 23 | 12 | 27 |
| 208 | H | 2 | 1 | 2 | 1 | 1 | 2 | 16 | 6 | 18 |
| 224 | H | 1 | 1 | 6 | 1 | 1 | 2 | 15 | 9 | 13 |
| 228 | H | 1 | 1 | 2 | 1 | 1 | 1 | 11 | 14 | 18 |
| 233 | H | 1 | 1 | 11 | 1 | 1 | 4 | 13 | 6 | 32 |
| 323 | H | 1 | 1 | 4 | 1 | 1 | 2 | 18 | 8 | 30 |
| 341 | H | 1 | 1 | 4 | 1 | 1 | 1 | 9 | 23 | 17 |
| 352 | H | 1 | 2 | 3 | 1 | 1 | 3 | 9 | 13 | 15 |
| 8 | M | 1 | 1 | 13 | 1 | 1 | 4 | 15 | 13 | 18 |
| 10 | M | 2 | 1 | 5 | 2 | 1 | 2 | 24 | 22 | 29 |
| 32 | M | 1 | 1 | 2 | 1 | 1 | 2 | 13 | 15 | 21 |
| 39 | M | 1 | 2 | 2 | 1 | 1 | 2 | 15 | 18 | 40 |
| 46 | M | 1 | 1 | 2 | 1 | 1 | 2 | 11 | 4 | 12 |
| 52 | M | 0 | 1 | 2 | 0 | 1 | 2 | 5 | 8 | 24 |
| 60 | M | 1 | 2 | 5 | 1 | 1 | 3 | 24 | 19 | 25 |
| 82 | M | 1 | 2 | 4 | 1 | 1 | 2 | 15 | 19 | 24 |
| 85 | M | 1 | 1 | 7 | 1 | 1 | 3 | 13 | 14 | 31 |
| 92 | M | 1 | 2 | 6 | 1 | 1 | 3 | 16 | 10 | 28 |
| 116 | M | 1 | 1 | 9 | 1 | 1 | 2 | 14 | 14 | 32 |
| 125 | M | 1 | 1 | 10 | 1 | 1 | 4 | 17 | 6 | 12 |
| 175 | M | 1 | 1 | 5 | 1 | 1 | 3 | 8 | 16 | 24 |
| 192 | M | 3 | 1 | 1 | 2 | 1 | 1 | 36 | 9 | 4 |
| 199 | M | 1 | 1 | 8 | 1 | 1 | 4 | 7 | 17 | 16 |
| 263 | M | 1 | 1 | 10 | 1 | 1 | 3 | 15 | 17 | 28 |
| 284 | M | 1 | 1 | 7 | 1 | 1 | 1 | 16 | 20 | 12 |
| 286 | M | 1 | 2 | 10 | 1 | 1 | 4 | 15 | 11 | 23 |
| 287 | M | 1 | 1 | 10 | 1 | 1 | 2 | 8 | 14 | 32 |
| 290 | M | 1 | 1 | 8 | 1 | 1 | 2 | 10 | 12 | 13 |
| 324 | M | 1 | 1 | 1 | 1 | 1 | 1 | 25 | 13 | 20 |
| 335 | M | 1 | 1 | 6 | 1 | 1 | 3 | 29 | 8 | 31 |
| 346 | M | 1 | 1 | 5 | 1 | 1 | 3 | 32 | 16 | 36 |
| 361 | M | 1 | 1 | 1 | 1 | 1 | 1 | 10 | 12 | 13 |
| 365 | M | 1 | 1 | 3 | 1 | 1 | 2 | 17 | 7 | 16 |
| 370 | M | 1 | 1 | 11 | 1 | 1 | 4 | 14 | 15 | 24 |
| 374 | M | 1 | 1 | 4 | 1 | 1 | 2 | 14 | 10 | 20 |
| 377 | M | 1 | 1 | 7 | 1 | 1 | 3 | 17 | 10 | 19 |
| 380 | M | 1 | 1 | 8 | 1 | 1 | 3 | 9 | 8 | 14 |
| 382 | M | 1 | 1 | 3 | 1 | 1 | 1 | 10 | 5 | 7 |
| 383 | M | 1 | 2 | 4 | 1 | 1 | 2 | 8 | 22 | 14 |
| 386 | M | 1 | 1 | 7 | 1 | 1 | 2 | 17 | 16 | 22 |
| 388 | M | 1 | 1 | 3 | 1 | 1 | 2 | 18 | 10 | 15 |
| 395 | M | 1 | 1 | 2 | 1 | 1 | 2 | 24 | 4 | 11 |
| 398 | M | 1 | 3 | 5 | 1 | 1 | 3 | 13 | 26 | 35 |
| 413 | M | 1 | 1 | 5 | 1 | 1 | 1 | 23 | 6 | 31 |
| 430 | M | 1 | 1 | 7 | 1 | 1 | 3 | 24 | 5 | 27 |
| 445 | M | 1 | 5 | 2 | 1 | 1 | 1 | 12 | 23 | 23 |
| 47 | L | 2 | 1 | 6 | 2 | 1 | 4 | 17 | 12 | 32 |
| 144 | L | 2 | 1 | 1 | 2 | 1 | 1 | 35 | 9 | 7 |
| 244 | L | 1 | 1 | 13 | 1 | 1 | 4 | 9 | 14 | 32 |
| 434 | L | 1 | 1 | 2 | 1 | 1 | 2 | 16 | 19 | 32 |

## I.2 Raw Data For The Use Of Search And Fileroom Facilities

Table I8
Learning Style

| Student | Learning Style | Search | | | Fileroom | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 32 | A | 0 | 1 | 4 | 2 | 1 | 2 |
| 39 | A | 1 | 2 | 18 | 1 | 1 | 1 |
| 52 | A | 1 | 2 | 7 | 0 | 0 | 0 |
| 60 | A | 6 | 2 | 9 | 1 | 3 | 3 |
| 82 | A | 1 | 0 | 7 | 1 | 5 | 6 |
| 85 | A | 1 | 2 | 15 | 1 | 0 | 3 |
| 92 | A | 1 | 2 | 11 | 1 | 0 | 0 |
| 116 | A | 2 | 1 | 12 | 0 | 1 | 2 |
| 144 | A | 5 | 1 | 1 | 2 | 0 | 0 |
| 175 | A | 1 | 3 | 8 | 0 | 2 | 2 |
| 208 | A | 3 | 1 | 8 | 1 | 0 | 4 |
| 244 | A | 1 | 1 | 38 | 0 | 1 | 1 |
| 323 | A | 1 | 3 | 9 | 1 | 0 | 6 |
| 341 | A | 1 | 2 | 11 | 0 | 1 | 0 |
| 361 | A | 0 | 0 | 2 | 1 | 2 | 1 |
| 383 | A | 1 | 4 | 2 | 0 | 5 | 3 |
| 398 | A | 1 | 3 | 10 | 1 | 2 | 1 |
| 413 | A | 6 | 1 | 9 | 0 | 0 | 3 |
| 430 | A | 1 | 1 | 14 | 3 | 0 | 1 |
| 46 | P | 3 | 1 | 2 | 1 | 0 | 0 |
| 199 | P | 2 | 1 | 20 | 1 | 0 | 0 |
| 228 | P | 3 | 2 | 3 | 0 | 1 | 0 |
| 290 | P | 1 | 3 | 13 | 0 | 1 | 0 |
| 374 | P | 4 | 0 | 9 | 0 | 1 | 0 |
| 377 | P | 2 | 0 | 16 | 1 | 2 | 1 |
| 8 | R | 0 | 0 | 16 | 2 | 3 | 0 |
| 41 | R | 5 | 0 | 11 | 3 | 2 | 3 |
| 47 | R | 2 | 1 | 15 | 2 | 3 | 1 |
| 71 | R | 3 | 1 | 4 | 0 | 0 | 2 |
| 125 | R | 2 | 1 | 7 | 0 | 0 | 0 |
| 192 | R | 6 | 1 | 1 | 3 | 1 | 0 |
| 201 | R | 4 | 0 | 18 | 2 | 1 | 0 |
| 263 | R | 2 | 0 | 12 | 0 | 1 | 2 |
| 284 | R | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | R | 3 | 1 | 31 | 0 | 0 | 4 |
| 324 | R | 4 | 1 | 3 | 3 | 1 | 1 |
| 380 | R | 3 | 4 | 10 | 0 | 0 | 0 |
| 382 | R | 1 | 1 | 4 | 1 | 0 | 0 |
| 395 | R | 3 | 1 | 5 | 2 | 0 | 1 |
| 434 | R | 2 | 4 | 10 | 2 | 0 | 5 |
| 445 | R | 2 | 0 | 7 | 1 | 9 | 1 |
| 10 | T | 1 | 0 | 7 | 3 | 3 | 4 |
| 111 | T | 2 | 1 | 13 | 2 | 0 | 1 |
| 224 | T | 0 | 0 | 8 | 1 | 1 | 0 |
| 233 | T | 2 | 1 | 13 | 0 | 0 | 3 |
| 287 | T | 1 | 1 | 14 | 0 | 2 | 5 |
| 335 | T | 12 | 3 | 17 | 3 | 0 | 1 |
| 346 | T | 7 | 4 | 17 | 7 | 1 | 6 |
| 352 | T | 3 | 4 | 8 | 0 | 1 | 0 |
| 365 | T | 2 | 0 | 4 | 3 | 2 | 0 |
| 370 | T | 5 | 0 | 27 | 1 | 5 | 5 |
| 386 | T | 2 | 1 | 16 | 4 | 2 | 0 |
| 388 | T | 1 | 1 | 3 | 3 | 0 | 0 |

Table I9
Gender

| Student | Gender | Search Task 1 | Search Task 2 | Search Task 3 | Fileroom Task 1 | Fileroom Task 2 | Fileroom Task 3 |
|---|---|---|---|---|---|---|---|
| 8 | F | 0 | 0 | 16 | 2 | 3 | 0 |
| 10 | F | 1 | 0 | 7 | 3 | 3 | 4 |
| 32 | F | 0 | 1 | 4 | 2 | 1 | 2 |
| 39 | F | 1 | 2 | 18 | 1 | 1 | 1 |
| 41 | F | 5 | 0 | 11 | 3 | 2 | 3 |
| 144 | F | 5 | 1 | 1 | 2 | 0 | 0 |
| 224 | F | 0 | 0 | 8 | 1 | 1 | 0 |
| 263 | F | 2 | 0 | 12 | 0 | 1 | 2 |
| 324 | F | 4 | 1 | 3 | 3 | 1 | 1 |
| 346 | F | 7 | 4 | 17 | 7 | 1 | 6 |
| 361 | F | 0 | 0 | 2 | 1 | 2 | 1 |
| 388 | F | 1 | 1 | 3 | 3 | 0 | 0 |
| 395 | F | 3 | 1 | 5 | 2 | 0 | 1 |
| 413 | F | 6 | 1 | 9 | 0 | 0 | 3 |
| 434 | F | 2 | 4 | 10 | 2 | 0 | 5 |
| 445 | F | 2 | 0 | 7 | 1 | 9 | 1 |
| 46 | M | 3 | 1 | 2 | 1 | 0 | 0 |
| 47 | M | 2 | 1 | 15 | 2 | 3 | 1 |
| 52 | M | 1 | 2 | 7 | 0 | 0 | 0 |
| 60 | M | 6 | 2 | 9 | 1 | 3 | 3 |
| 71 | M | 3 | 1 | 4 | 0 | 0 | 2 |
| 82 | M | 1 | 0 | 7 | 1 | 5 | 6 |
| 85 | M | 1 | 2 | 15 | 1 | 0 | 3 |
| 92 | M | 1 | 2 | 11 | 1 | 0 | 0 |
| 111 | M | 2 | 1 | 13 | 2 | 0 | 1 |
| 116 | M | 2 | 1 | 12 | 0 | 1 | 2 |
| 125 | M | 2 | 1 | 7 | 0 | 0 | 0 |
| 175 | M | 1 | 3 | 8 | 0 | 2 | 2 |
| 192 | M | 6 | 1 | 1 | 3 | 1 | 0 |
| 199 | M | 2 | 1 | 20 | 1 | 0 | 0 |
| 201 | M | 4 | 0 | 18 | 2 | 1 | 0 |
| 208 | M | 3 | 1 | 8 | 1 | 0 | 4 |
| 228 | M | 3 | 2 | 3 | 0 | 1 | 0 |
| 233 | M | 2 | 1 | 13 | 0 | 0 | 3 |
| 244 | M | 1 | 1 | 38 | 0 | 1 | 1 |
| 284 | M | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | M | 3 | 1 | 31 | 0 | 0 | 4 |
| 287 | M | 1 | 1 | 14 | 0 | 2 | 5 |
| 290 | M | 1 | 3 | 13 | 0 | 1 | 0 |
| 323 | M | 1 | 3 | 9 | 1 | 0 | 6 |
| 335 | M | 12 | 3 | 17 | 3 | 0 | 1 |
| 341 | M | 1 | 2 | 11 | 0 | 1 | 0 |
| 352 | M | 3 | 4 | 8 | 0 | 1 | 0 |
| 365 | M | 2 | 0 | 4 | 3 | 2 | 0 |
| 370 | M | 5 | 0 | 27 | 1 | 5 | 5 |
| 374 | M | 4 | 0 | 9 | 0 | 1 | 0 |
| 377 | M | 2 | 0 | 16 | 1 | 2 | 1 |
| 380 | M | 3 | 4 | 10 | 0 | 0 | 0 |
| 382 | M | 1 | 1 | 4 | 1 | 0 | 0 |
| 383 | M | 1 | 4 | 2 | 0 | 5 | 3 |
| 386 | M | 2 | 1 | 16 | 4 | 2 | 0 |
| 398 | M | 1 | 3 | 10 | 1 | 2 | 1 |
| 430 | M | 1 | 1 | 14 | 3 | 0 | 1 |

Table I10
Ethnic Origin

| Student | Ethnic Origin | Search Task 1 | Search Task 2 | Search Task 3 | Fileroom Task 1 | Fileroom Task 2 | Fileroom Task 3 |
|---|---|---|---|---|---|---|---|
| 8 | A | 0 | 0 | 16 | 2 | 3 | 0 |
| 10 | A | 1 | 0 | 7 | 3 | 3 | 4 |
| 32 | A | 0 | 1 | 4 | 2 | 1 | 2 |
| 41 | A | 5 | 0 | 11 | 3 | 2 | 3 |
| 46 | A | 3 | 1 | 2 | 1 | 0 | 0 |
| 52 | A | 1 | 2 | 7 | 0 | 0 | 0 |
| 85 | A | 1 | 2 | 15 | 1 | 0 | 3 |
| 92 | A | 1 | 2 | 11 | 1 | 0 | 0 |
| 111 | A | 2 | 1 | 13 | 2 | 0 | 1 |
| 192 | A | 6 | 1 | 1 | 3 | 1 | 0 |
| 208 | A | 3 | 1 | 8 | 1 | 0 | 4 |
| 224 | A | 0 | 0 | 8 | 1 | 1 | 0 |
| 228 | A | 3 | 2 | 3 | 0 | 1 | 0 |
| 287 | A | 1 | 1 | 14 | 0 | 2 | 5 |
| 335 | A | 12 | 3 | 17 | 3 | 0 | 1 |
| 361 | A | 0 | 0 | 2 | 1 | 2 | 1 |
| 365 | A | 2 | 0 | 4 | 3 | 2 | 0 |
| 395 | A | 3 | 1 | 5 | 2 | 0 | 1 |
| 413 | A | 6 | 1 | 9 | 0 | 0 | 3 |
| 39 | E | 1 | 2 | 18 | 1 | 1 | 1 |
| 47 | E | 2 | 1 | 15 | 2 | 3 | 1 |
| 60 | E | 6 | 2 | 9 | 1 | 3 | 3 |
| 71 | E | 3 | 1 | 4 | 0 | 0 | 2 |
| 82 | E | 1 | 0 | 7 | 1 | 5 | 6 |
| 116 | E | 2 | 1 | 12 | 0 | 1 | 2 |
| 125 | E | 2 | 1 | 7 | 0 | 0 | 0 |
| 144 | E | 5 | 1 | 1 | 2 | 0 | 0 |
| 175 | E | 1 | 3 | 8 | 0 | 2 | 2 |
| 199 | E | 2 | 1 | 20 | 1 | 0 | 0 |
| 201 | E | 4 | 0 | 18 | 2 | 1 | 0 |
| 233 | E | 2 | 1 | 13 | 0 | 0 | 3 |
| 244 | E | 1 | 1 | 38 | 0 | 1 | 1 |
| 263 | E | 2 | 0 | 12 | 0 | 1 | 2 |
| 284 | E | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | E | 3 | 1 | 31 | 0 | 0 | 4 |
| 290 | E | 1 | 3 | 13 | 0 | 1 | 0 |
| 323 | E | 1 | 3 | 9 | 1 | 0 | 6 |
| 324 | E | 4 | 1 | 3 | 3 | 1 | 1 |
| 341 | E | 1 | 2 | 11 | 0 | 1 | 0 |
| 346 | E | 7 | 4 | 17 | 7 | 1 | 6 |
| 352 | E | 3 | 4 | 8 | 0 | 1 | 0 |
| 370 | E | 5 | 0 | 27 | 1 | 5 | 5 |
| 374 | E | 4 | 0 | 9 | 0 | 1 | 0 |
| 377 | E | 2 | 0 | 16 | 1 | 2 | 1 |
| 380 | E | 3 | 4 | 10 | 0 | 0 | 0 |
| 382 | E | 1 | 1 | 4 | 1 | 0 | 0 |
| 383 | E | 1 | 4 | 2 | 0 | 5 | 3 |
| 386 | E | 2 | 1 | 16 | 4 | 2 | 0 |
| 398 | E | 1 | 3 | 10 | 1 | 2 | 1 |
| 430 | E | 1 | 1 | 14 | 3 | 0 | 1 |
| 434 | E | 2 | 4 | 10 | 2 | 0 | 5 |
| 445 | E | 2 | 0 | 7 | 1 | 9 | 1 |
| 388 | O | 1 | 1 | 3 | 3 | 0 | 0 |

## Table I11
## Social Class

| Student | Social Class | Search Task 1 | Search Task 2 | Search Task 3 | Fileroom Task 1 | Fileroom Task 2 | Fileroom Task 3 |
|---|---|---|---|---|---|---|---|
| 8 | 1 | 0 | 0 | 16 | 2 | 3 | 0 |
| 41 | 1 | 5 | 0 | 11 | 3 | 2 | 3 |
| 47 | 1 | 2 | 1 | 15 | 2 | 3 | 1 |
| 71 | 1 | 3 | 1 | 4 | 0 | 0 | 2 |
| 144 | 1 | 5 | 1 | 1 | 2 | 0 | 0 |
| 201 | 1 | 4 | 0 | 18 | 2 | 1 | 0 |
| 228 | 1 | 3 | 2 | 3 | 0 | 1 | 0 |
| 244 | 1 | 1 | 1 | 38 | 0 | 1 | 1 |
| 386 | 1 | 2 | 1 | 16 | 4 | 2 | 0 |
| 445 | 1 | 2 | 0 | 7 | 1 | 9 | 1 |
| 39 | 2 | 1 | 2 | 18 | 1 | 1 | 1 |
| 46 | 2 | 3 | 1 | 2 | 1 | 0 | 0 |
| 52 | 2 | 1 | 2 | 7 | 0 | 0 | 0 |
| 60 | 2 | 6 | 2 | 9 | 1 | 3 | 3 |
| 82 | 2 | 1 | 0 | 7 | 1 | 5 | 6 |
| 85 | 2 | 1 | 2 | 15 | 1 | 0 | 3 |
| 92 | 2 | 1 | 2 | 11 | 1 | 0 | 0 |
| 116 | 2 | 2 | 1 | 12 | 0 | 1 | 2 |
| 125 | 2 | 2 | 1 | 7 | 0 | 0 | 0 |
| 175 | 2 | 1 | 3 | 8 | 0 | 2 | 2 |
| 199 | 2 | 2 | 1 | 20 | 1 | 0 | 0 |
| 208 | 2 | 3 | 1 | 8 | 1 | 0 | 4 |
| 224 | 2 | 0 | 0 | 8 | 1 | 1 | 0 |
| 233 | 2 | 2 | 1 | 13 | 0 | 0 | 3 |
| 284 | 2 | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | 2 | 3 | 1 | 31 | 0 | 0 | 4 |
| 323 | 2 | 1 | 3 | 9 | 1 | 0 | 6 |
| 341 | 2 | 1 | 2 | 11 | 0 | 1 | 0 |
| 370 | 2 | 5 | 0 | 27 | 1 | 5 | 5 |
| 374 | 2 | 4 | 0 | 9 | 0 | 1 | 0 |
| 382 | 2 | 1 | 1 | 4 | 1 | 0 | 0 |
| 383 | 2 | 1 | 4 | 2 | 0 | 5 | 3 |
| 413 | 2 | 6 | 1 | 9 | 0 | 0 | 3 |
| 430 | 2 | 1 | 1 | 14 | 3 | 0 | 1 |
| 32 | 3 | 0 | 1 | 4 | 2 | 1 | 2 |
| 111 | 3 | 2 | 1 | 13 | 2 | 0 | 1 |
| 192 | 3 | 6 | 1 | 1 | 3 | 1 | 0 |
| 263 | 3 | 2 | 0 | 12 | 0 | 1 | 2 |
| 287 | 3 | 1 | 1 | 14 | 0 | 2 | 5 |
| 290 | 3 | 1 | 3 | 13 | 0 | 1 | 0 |
| 324 | 3 | 4 | 1 | 3 | 3 | 1 | 1 |
| 335 | 3 | 12 | 3 | 17 | 3 | 0 | 1 |
| 346 | 3 | 7 | 4 | 17 | 7 | 1 | 6 |
| 352 | 3 | 3 | 4 | 8 | 0 | 1 | 0 |
| 365 | 3 | 2 | 0 | 4 | 3 | 2 | 0 |
| 377 | 3 | 2 | 0 | 16 | 1 | 2 | 1 |
| 380 | 3 | 3 | 4 | 10 | 0 | 0 | 0 |
| 388 | 3 | 1 | 1 | 3 | 3 | 0 | 0 |
| 395 | 3 | 3 | 1 | 5 | 2 | 0 | 1 |
| 398 | 3 | 1 | 3 | 10 | 1 | 2 | 1 |
| 434 | 3 | 2 | 4 | 10 | 2 | 0 | 5 |
| 10 | 4 | 1 | 0 | 7 | 3 | 3 | 4 |
| 361 | 4 | 0 | 0 | 2 | 1 | 2 | 1 |

Table I12
Computer Affinity

| Student | Computer Affinity | Search | | | Fileroom | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | H | 0 | 0 | 16 | 2 | 3 | 0 |
| 10 | H | 1 | 0 | 7 | 3 | 3 | 4 |
| 41 | H | 5 | 0 | 11 | 3 | 2 | 3 |
| 46 | H | 3 | 1 | 2 | 1 | 0 | 0 |
| 47 | H | 2 | 1 | 15 | 2 | 3 | 1 |
| 52 | H | 1 | 2 | 7 | 0 | 0 | 0 |
| 60 | H | 6 | 2 | 9 | 1 | 3 | 3 |
| 71 | H | 3 | 1 | 4 | 0 | 0 | 2 |
| 82 | H | 1 | 0 | 7 | 1 | 5 | 6 |
| 92 | H | 1 | 2 | 11 | 1 | 0 | 0 |
| 111 | H | 2 | 1 | 13 | 2 | 0 | 1 |
| 116 | H | 2 | 1 | 12 | 0 | 1 | 2 |
| 125 | H | 2 | 1 | 7 | 0 | 0 | 0 |
| 175 | H | 1 | 3 | 8 | 0 | 2 | 2 |
| 192 | H | 6 | 1 | 1 | 3 | 1 | 0 |
| 199 | H | 2 | 1 | 20 | 1 | 0 | 0 |
| 201 | H | 4 | 0 | 18 | 2 | 1 | 0 |
| 208 | H | 3 | 1 | 8 | 1 | 0 | 4 |
| 224 | H | 0 | 0 | 8 | 1 | 1 | 0 |
| 228 | H | 3 | 2 | 3 | 0 | 1 | 0 |
| 233 | H | 2 | 1 | 13 | 0 | 0 | 3 |
| 244 | H | 1 | 1 | 38 | 0 | 1 | 1 |
| 263 | H | 2 | 0 | 12 | 0 | 1 | 2 |
| 284 | H | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | H | 3 | 1 | 31 | 0 | 0 | 4 |
| 287 | H | 1 | 1 | 14 | 0 | 2 | 5 |
| 290 | H | 1 | 3 | 13 | 0 | 1 | 0 |
| 323 | H | 1 | 3 | 9 | 1 | 0 | 6 |
| 324 | H | 4 | 1 | 3 | 3 | 1 | 1 |
| 335 | H | 12 | 3 | 17 | 3 | 0 | 1 |
| 341 | H | 1 | 2 | 11 | 0 | 1 | 0 |
| 346 | H | 7 | 4 | 17 | 7 | 1 | 6 |
| 352 | H | 3 | 4 | 8 | 0 | 1 | 0 |
| 361 | H | 0 | 0 | 2 | 1 | 2 | 1 |
| 370 | H | 5 | 0 | 27 | 1 | 5 | 5 |
| 374 | H | 4 | 0 | 9 | 0 | 1 | 0 |
| 377 | H | 2 | 0 | 16 | 1 | 2 | 1 |
| 380 | H | 3 | 4 | 10 | 0 | 0 | 0 |
| 382 | H | 1 | 1 | 4 | 1 | 0 | 0 |
| 383 | H | 1 | 4 | 2 | 0 | 5 | 3 |
| 386 | H | 2 | 1 | 16 | 4 | 2 | 0 |
| 395 | H | 3 | 1 | 5 | 2 | 0 | 1 |
| 398 | H | 1 | 3 | 10 | 1 | 2 | 1 |
| 413 | H | 6 | 1 | 9 | 0 | 0 | 3 |
| 430 | H | 1 | 1 | 14 | 3 | 0 | 1 |
| 445 | H | 2 | 0 | 7 | 1 | 9 | 1 |
| 39 | M | 1 | 2 | 18 | 1 | 1 | 1 |
| 85 | M | 1 | 2 | 15 | 1 | 0 | 3 |
| 144 | M | 5 | 1 | 1 | 2 | 0 | 0 |
| 388 | M | 1 | 1 | 3 | 3 | 0 | 0 |
| 32 | L | 0 | 1 | 4 | 2 | 1 | 2 |
| 365 | L | 2 | 0 | 4 | 3 | 2 | 0 |
| 434 | L | 2 | 4 | 10 | 2 | 0 | 5 |

## Table I13
## Computer Literacy

| Student | Computer Literacy | Search | | | Fileroom | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 10 | H | 1 | 0 | 7 | 3 | 3 | 4 |
| 41 | H | 5 | 0 | 11 | 3 | 2 | 3 |
| 46 | H | 3 | 1 | 2 | 1 | 0 | 0 |
| 52 | H | 1 | 2 | 7 | 0 | 0 | 0 |
| 71 | H | 3 | 1 | 4 | 0 | 0 | 2 |
| 85 | H | 1 | 2 | 15 | 1 | 0 | 3 |
| 92 | H | 1 | 2 | 11 | 1 | 0 | 0 |
| 111 | H | 2 | 1 | 13 | 2 | 0 | 1 |
| 116 | H | 2 | 1 | 12 | 0 | 1 | 2 |
| 125 | H | 2 | 1 | 7 | 0 | 0 | 0 |
| 192 | H | 6 | 1 | 1 | 3 | 1 | 0 |
| 233 | H | 2 | 1 | 13 | 0 | 0 | 3 |
| 284 | H | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | H | 3 | 1 | 31 | 0 | 0 | 4 |
| 323 | H | 1 | 3 | 9 | 1 | 0 | 6 |
| 335 | H | 12 | 3 | 17 | 3 | 0 | 1 |
| 341 | H | 1 | 2 | 11 | 0 | 1 | 0 |
| 346 | H | 7 | 4 | 17 | 7 | 1 | 6 |
| 352 | H | 3 | 4 | 8 | 0 | 1 | 0 |
| 361 | H | 0 | 0 | 2 | 1 | 2 | 1 |
| 382 | H | 1 | 1 | 4 | 1 | 0 | 0 |
| 386 | H | 2 | 1 | 16 | 4 | 2 | 0 |
| 430 | H | 1 | 1 | 14 | 3 | 0 | 1 |
| 445 | H | 2 | 0 | 7 | 1 | 9 | 1 |
| 8 | M | 0 | 0 | 16 | 2 | 3 | 0 |
| 39 | M | 1 | 2 | 18 | 1 | 1 | 1 |
| 47 | M | 2 | 1 | 15 | 2 | 3 | 1 |
| 60 | M | 6 | 2 | 9 | 1 | 3 | 3 |
| 82 | M | 1 | 0 | 7 | 1 | 5 | 6 |
| 144 | M | 5 | 1 | 1 | 2 | 0 | 0 |
| 175 | M | 1 | 3 | 8 | 0 | 2 | 2 |
| 199 | M | 2 | 1 | 20 | 1 | 0 | 0 |
| 201 | M | 4 | 0 | 18 | 2 | 1 | 0 |
| 208 | M | 3 | 1 | 8 | 1 | 0 | 4 |
| 224 | M | 0 | 0 | 8 | 1 | 1 | 0 |
| 228 | M | 3 | 2 | 3 | 0 | 1 | 0 |
| 244 | M | 1 | 1 | 38 | 0 | 1 | 1 |
| 263 | M | 2 | 0 | 12 | 0 | 1 | 2 |
| 287 | M | 1 | 1 | 14 | 0 | 2 | 5 |
| 290 | M | 1 | 3 | 13 | 0 | 1 | 0 |
| 324 | M | 4 | 1 | 3 | 3 | 1 | 1 |
| 365 | M | 2 | 0 | 4 | 3 | 2 | 0 |
| 370 | M | 5 | 0 | 27 | 1 | 5 | 5 |
| 374 | M | 4 | 0 | 9 | 0 | 1 | 0 |
| 377 | M | 2 | 0 | 16 | 1 | 2 | 1 |
| 380 | M | 3 | 4 | 10 | 0 | 0 | 0 |
| 383 | M | 1 | 4 | 2 | 0 | 5 | 3 |
| 388 | M | 1 | 1 | 3 | 3 | 0 | 0 |
| 395 | M | 3 | 1 | 5 | 2 | 0 | 1 |
| 398 | M | 1 | 3 | 10 | 1 | 2 | 1 |
| 413 | M | 6 | 1 | 9 | 0 | 0 | 3 |
| 434 | M | 2 | 4 | 10 | 2 | 0 | 5 |
| 32 | L | 0 | 1 | 4 | 2 | 1 | 2 |

Table I14
Search Experience

| Student | Search Experience | Search Task 1 | Search Task 2 | Search Task 3 | Fileroom Task 1 | Fileroom Task 2 | Fileroom Task 3 |
|---|---|---|---|---|---|---|---|
| 41 | H | 5 | 0 | 11 | 3 | 2 | 3 |
| 71 | H | 3 | 1 | 4 | 0 | 0 | 2 |
| 111 | H | 2 | 1 | 13 | 2 | 0 | 1 |
| 201 | H | 4 | 0 | 18 | 2 | 1 | 0 |
| 208 | H | 3 | 1 | 8 | 1 | 0 | 4 |
| 224 | H | 0 | 0 | 8 | 1 | 1 | 0 |
| 228 | H | 3 | 2 | 3 | 0 | 1 | 0 |
| 233 | H | 2 | 1 | 13 | 0 | 0 | 3 |
| 323 | H | 1 | 3 | 9 | 1 | 0 | 6 |
| 341 | H | 1 | 2 | 11 | 0 | 1 | 0 |
| 352 | H | 3 | 4 | 8 | 0 | 1 | 0 |
| 8 | M | 0 | 0 | 16 | 2 | 3 | 0 |
| 10 | M | 1 | 0 | 7 | 3 | 3 | 4 |
| 32 | M | 0 | 1 | 4 | 2 | 1 | 2 |
| 39 | M | 1 | 2 | 18 | 1 | 1 | 1 |
| 46 | M | 3 | 1 | 2 | 1 | 0 | 0 |
| 52 | M | 1 | 2 | 7 | 0 | 0 | 0 |
| 60 | M | 6 | 2 | 9 | 1 | 3 | 3 |
| 82 | M | 1 | 0 | 7 | 1 | 5 | 6 |
| 85 | M | 1 | 2 | 15 | 1 | 0 | 3 |
| 92 | M | 1 | 2 | 11 | 1 | 0 | 0 |
| 116 | M | 2 | 1 | 12 | 0 | 1 | 2 |
| 125 | M | 2 | 1 | 7 | 0 | 0 | 0 |
| 175 | M | 1 | 3 | 8 | 0 | 2 | 2 |
| 192 | M | 6 | 1 | 1 | 3 | 1 | 0 |
| 199 | M | 2 | 1 | 20 | 1 | 0 | 0 |
| 263 | M | 2 | 0 | 12 | 0 | 1 | 2 |
| 284 | M | 1 | 2 | 9 | 0 | 2 | 0 |
| 286 | M | 3 | 1 | 31 | 0 | 0 | 4 |
| 287 | M | 1 | 1 | 14 | 0 | 2 | 5 |
| 290 | M | 1 | 3 | 13 | 0 | 1 | 0 |
| 324 | M | 4 | 1 | 3 | 3 | 1 | 1 |
| 335 | M | 12 | 3 | 17 | 3 | 0 | 1 |
| 346 | M | 7 | 4 | 17 | 7 | 1 | 6 |
| 361 | M | 0 | 0 | 2 | 1 | 2 | 1 |
| 365 | M | 2 | 0 | 4 | 3 | 2 | 0 |
| 370 | M | 5 | 0 | 27 | 1 | 5 | 5 |
| 374 | M | 4 | 0 | 9 | 0 | 1 | 0 |
| 377 | M | 2 | 0 | 16 | 1 | 2 | 1 |
| 380 | M | 3 | 4 | 10 | 0 | 0 | 0 |
| 382 | M | 1 | 1 | 4 | 1 | 0 | 0 |
| 383 | M | 1 | 4 | 2 | 0 | 5 | 3 |
| 386 | M | 2 | 1 | 16 | 4 | 2 | 0 |
| 388 | M | 1 | 1 | 3 | 3 | 0 | 0 |
| 395 | M | 3 | 1 | 5 | 2 | 0 | 1 |
| 398 | M | 1 | 3 | 10 | 1 | 2 | 1 |
| 413 | M | 6 | 1 | 9 | 0 | 0 | 3 |
| 430 | M | 1 | 1 | 14 | 3 | 0 | 1 |
| 445 | M | 2 | 0 | 7 | 1 | 9 | 1 |
| 47 | L | 2 | 1 | 15 | 2 | 3 | 1 |
| 144 | L | 5 | 1 | 1 | 2 | 0 | 0 |
| 244 | L | 1 | 1 | 38 | 0 | 1 | 1 |
| 434 | L | 2 | 4 | 10 | 2 | 0 | 5 |

## I.3 Raw Data For Constraint By Document Content And Operational Facilities

Table I15
Learning Style

| Student | Learning Style | Document Content | | | Operational Facilities | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 32 | A | C | U | C | U | U | U |
| 39 | A | C | U | U | U | U | U |
| 52 | A | C | C | C | U | U | C |
| 60 | A | C | C | C | U | U | U |
| 82 | A | U | C | C | U | C | U |
| 85 | A | C | C | C | U | U | U |
| 92 | A | U | U | C | U | U | U |
| 116 | A | C | C | C | U | U | U |
| 144 | A | C | U | U | U | U | U |
| 175 | A | U | U | C | U | U | U |
| 208 | A | C | C | C | C | ? | C |
| 244 | A | U | U | C | U | U | C |
| 323 | A | U | U | C | C | C | C |
| 341 | A | U | C | C | U | C | C |
| 361 | A | U | U | U | U | U | U |
| 383 | A | U | U | C | ? | ? | ? |
| 398 | A | U | U | C | U | U | U |
| 413 | A | U | U | U | U | U | U |
| 430 | A | U | U | C | U | U | U |
| | | | | | | | |
| 46 | P | C | C | C | U | U | U |
| 199 | P | C | C | C | ? | ? | C |
| 228 | P | U | C | U | U | U | C |
| 290 | P | U | U | U | U | U | U |
| 374 | P | U | U | C | U | U | C |
| 377 | P | U | C | U | U | U | U |
| | | | | | | | |
| 8 | R | U | U | C | U | U | U |
| 41 | R | U | U | C | U | U | U |
| 47 | R | U | C | U | U | U | U |
| 71 | R | U | C | U | U | U | C |
| 125 | R | C | U | C | U | U | U |
| 192 | R | U | U | C | C | ? | ? |
| 201 | R | C | C | U | ? | C | ? |
| 263 | R | U | U | U | U | U | U |
| 284 | R | U | U | C | ? | ? | ? |
| 286 | R | U | U | C | C | U | C |
| 324 | R | U | C | U | U | U | U |
| 380 | R | C | U | U | U | U | U |
| 382 | R | U | U | C | ? | ? | ? |
| 395 | R | C | U | C | U | U | U |
| 434 | R | U | U | U | U | U | U |
| 445 | R | U | U | U | U | U | U |
| | | | | | | | |
| 10 | T | U | U | C | U | U | U |
| 111 | T | C | C | C | U | U | U |
| 224 | T | C | C | C | U | U | C |
| 233 | T | C | C | C | U | U | U |
| 287 | T | U | U | C | ? | C | C |
| 335 | T | C | C | C | U | U | C |
| 346 | T | U | U | U | U | U | U |
| 352 | T | C | U | U | U | U | U |
| 365 | T | C | C | C | U | U | U |
| 370 | T | U | U | U | U | U | U |
| 386 | T | U | C | C | U | U | C |
| 388 | T | U | U | U | C | U | U |

Table I16
Gender

| Student | Gender | Document Content | | | Operational Facilities | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | F | U | U | C | U | U | U |
| 10 | F | U | U | C | U | U | U |
| 32 | F | C | U | C | U | U | U |
| 39 | F | C | U | U | U | U | U |
| 41 | F | U | U | C | U | U | U |
| 144 | F | C | U | U | U | U | U |
| 224 | F | C | C | C | U | U | C |
| 263 | F | U | U | U | U | U | U |
| 324 | F | U | C | U | U | U | U |
| 346 | F | U | U | U | U | U | U |
| 361 | F | U | U | U | U | U | U |
| 388 | F | U | U | U | C | U | U |
| 395 | F | C | U | C | U | U | U |
| 413 | F | U | U | U | U | U | U |
| 434 | F | U | U | U | U | U | U |
| 445 | F | U | U | U | U | U | U |
| 46 | M | C | C | C | U | U | U |
| 47 | M | U | C | U | U | U | U |
| 52 | M | C | C | C | U | U | C |
| 60 | M | C | C | C | U | U | U |
| 71 | M | U | C | U | U | U | C |
| 82 | M | U | C | C | U | C | U |
| 85 | M | C | C | C | U | U | U |
| 92 | M | U | U | C | U | U | U |
| 111 | M | C | C | C | U | U | U |
| 116 | M | C | C | C | U | U | U |
| 125 | M | C | U | C | U | U | U |
| 175 | M | U | U | C | U | U | U |
| 192 | M | U | U | C | C | ? | ? |
| 199 | M | C | C | C | ? | ? | C |
| 201 | M | C | C | U | ? | C | ? |
| 208 | M | C | C | C | C | ? | C |
| 228 | M | U | C | U | U | U | C |
| 233 | M | C | C | C | U | U | U |
| 244 | M | U | U | C | U | U | C |
| 284 | M | U | U | C | ? | ? | ? |
| 286 | M | U | U | C | C | U | C |
| 287 | M | U | U | C | ? | C | C |
| 290 | M | U | U | U | U | U | U |
| 323 | M | U | U | C | C | C | C |
| 335 | M | C | C | C | U | U | C |
| 341 | M | U | C | C | U | C | C |
| 352 | M | C | U | U | U | U | U |
| 365 | M | C | C | C | U | U | U |
| 370 | M | U | U | U | U | U | U |
| 374 | M | U | U | C | U | U | C |
| 377 | M | U | C | U | U | U | U |
| 380 | M | C | U | U | U | U | U |
| 382 | M | U | U | C | ? | ? | ? |
| 383 | M | U | U | C | ? | ? | ? |
| 386 | M | U | C | C | U | U | C |
| 398 | M | U | U | C | U | U | U |
| 430 | M | U | U | C | U | U | U |

## Table I17
## Ethnic Origin

| Student | Ethnic Origin | Document Content | | | Operational Facilities | | |
|---|---|---|---|---|---|---|---|
| | | Task 1 | Task 2 | Task 3 | Task 1 | Task 2 | Task 3 |
| 8 | A | U | U | C | U | U | U |
| 10 | A | U | U | C | U | U | U |
| 32 | A | C | U | C | U | U | U |
| 41 | A | U | U | C | U | U | U |
| 46 | A | C | C | C | U | U | U |
| 52 | A | C | C | C | U | U | C |
| 85 | A | C | C | C | U | U | U |
| 92 | A | U | U | C | U | U | U |
| 111 | A | C | C | C | U | U | U |
| 192 | A | U | U | C | C | ? | ? |
| 208 | A | C | C | C | C | ? | C |
| 224 | A | C | C | C | U | U | C |
| 228 | A | U | C | U | U | U | C |
| 287 | A | U | U | C | ? | C | C |
| 335 | A | C | C | C | U | U | C |
| 361 | A | U | U | U | U | U | U |
| 365 | A | C | C | C | U | U | U |
| 395 | A | C | U | C | U | U | U |
| 413 | A | U | U | U | U | U | U |
| 39 | E | C | U | U | U | U | U |
| 47 | E | U | C | U | U | U | U |
| 60 | E | C | C | C | U | U | U |
| 71 | E | U | C | U | U | U | C |
| 82 | E | U | C | C | U | C | U |
| 116 | E | C | C | C | U | U | U |
| 125 | E | C | U | C | U | U | U |
| 144 | E | C | U | U | U | U | U |
| 175 | E | U | U | C | U | U | U |
| 199 | E | C | C | C | ? | ? | C |
| 201 | E | C | C | U | ? | C | ? |
| 233 | E | C | C | C | U | U | U |
| 244 | E | U | U | C | U | U | C |
| 263 | E | U | U | U | U | U | U |
| 284 | E | U | U | C | ? | ? | ? |
| 286 | E | U | U | C | C | U | C |
| 290 | E | U | U | U | U | U | U |
| 323 | E | U | U | C | C | C | C |
| 324 | E | U | C | U | U | U | U |
| 341 | E | U | C | C | U | C | C |
| 346 | E | U | U | U | U | U | U |
| 352 | E | C | U | U | U | U | U |
| 370 | E | U | U | U | U | U | U |
| 374 | E | U | U | C | U | U | C |
| 377 | E | U | C | U | U | U | U |
| 380 | E | C | U | U | U | U | U |
| 382 | E | U | U | C | ? | ? | ? |
| 383 | E | U | U | C | ? | ? | ? |
| 386 | E | U | C | C | U | U | C |
| 398 | E | U | U | C | U | U | U |
| 430 | E | U | U | C | U | U | U |
| 434 | E | U | U | U | U | U | U |
| 445 | E | U | U | U | U | U | U |
| 388 | O | U | U | U | C | U | U |

# Table I18
## Social Class

| Student | Social Class | Document Content Task 1 | Document Content Task 2 | Document Content Task 3 | Operational Facilities Task 1 | Operational Facilities Task 2 | Operational Facilities Task 3 |
|---|---|---|---|---|---|---|---|
| 8 | 1 | U | U | C | U | U | U |
| 41 | 1 | U | U | C | U | U | U |
| 47 | 1 | U | C | U | U | U | U |
| 71 | 1 | U | C | U | U | U | C |
| 144 | 1 | C | U | U | U | U | U |
| 201 | 1 | C | C | U | ? | C | ? |
| 228 | 1 | U | C | U | U | U | C |
| 244 | 1 | U | U | C | U | U | C |
| 386 | 1 | U | C | C | U | U | C |
| 445 | 1 | U | U | U | U | U | U |
| 39 | 2 | C | U | U | U | U | U |
| 46 | 2 | C | C | C | U | U | U |
| 52 | 2 | C | C | C | U | U | C |
| 60 | 2 | C | C | C | U | U | U |
| 82 | 2 | U | C | C | U | C | U |
| 85 | 2 | C | C | C | U | U | U |
| 92 | 2 | U | U | C | U | U | U |
| 116 | 2 | C | C | C | U | U | U |
| 125 | 2 | C | U | C | U | U | U |
| 175 | 2 | U | U | C | U | U | U |
| 199 | 2 | C | C | C | ? | ? | C |
| 208 | 2 | C | C | C | C | ? | C |
| 224 | 2 | C | C | C | U | U | C |
| 233 | 2 | C | C | C | U | U | U |
| 284 | 2 | U | U | C | ? | ? | ? |
| 286 | 2 | U | U | C | C | U | C |
| 323 | 2 | U | U | C | C | C | C |
| 341 | 2 | U | C | C | U | C | C |
| 370 | 2 | U | U | U | U | U | U |
| 374 | 2 | U | U | C | U | U | C |
| 382 | 2 | U | U | C | ? | ? | ? |
| 383 | 2 | U | U | C | ? | ? | ? |
| 413 | 2 | U | U | U | U | U | U |
| 430 | 2 | U | U | C | U | U | U |
| 32 | 3 | C | U | C | U | U | U |
| 111 | 3 | C | C | C | U | U | U |
| 192 | 3 | U | U | C | C | ? | ? |
| 263 | 3 | U | U | U | U | U | U |
| 287 | 3 | U | U | C | ? | C | C |
| 290 | 3 | U | U | U | U | U | U |
| 324 | 3 | U | C | U | U | U | U |
| 335 | 3 | C | C | C | U | U | C |
| 346 | 3 | U | U | U | U | U | U |
| 352 | 3 | C | U | U | U | U | U |
| 365 | 3 | C | C | C | U | U | U |
| 377 | 3 | U | C | U | U | U | U |
| 380 | 3 | C | U | U | U | U | U |
| 388 | 3 | U | U | U | C | U | U |
| 395 | 3 | C | U | C | U | U | U |
| 398 | 3 | U | U | C | U | U | U |
| 434 | 3 | U | U | U | U | U | U |
| 10 | 4 | U | U | C | U | U | U |
| 361 | 4 | U | U | U | U | U | U |

Table I19
Computer Affinity

| Student | Computer Affinity | Document Content | | | Operational Facilities | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 8 | H | U | U | C | U | U | U |
| 10 | H | U | U | C | U | U | U |
| 41 | H | U | U | C | U | U | U |
| 46 | H | C | C | C | U | U | U |
| 47 | H | U | C | U | U | U | U |
| 52 | H | C | C | C | U | U | C |
| 60 | H | C | C | C | U | U | U |
| 71 | H | U | C | U | U | U | C |
| 82 | H | U | C | C | U | C | U |
| 92 | H | U | U | C | U | U | U |
| 111 | H | C | C | C | U | U | U |
| 116 | H | C | C | C | U | U | U |
| 125 | H | C | U | C | U | U | U |
| 175 | H | U | U | C | U | U | U |
| 192 | H | U | U | C | C | ? | ? |
| 199 | H | C | C | C | ? | ? | C |
| 201 | H | C | C | U | ? | C | ? |
| 208 | H | C | C | C | C | ? | C |
| 224 | H | C | C | C | U | U | C |
| 228 | H | U | C | U | U | U | C |
| 233 | H | C | C | C | U | U | U |
| 244 | H | U | U | C | U | U | C |
| 263 | H | U | U | U | U | U | U |
| 284 | H | U | U | C | ? | ? | ? |
| 286 | H | U | U | C | C | U | C |
| 287 | H | U | U | C | ? | C | C |
| 290 | H | U | U | U | U | U | U |
| 323 | H | U | U | C | C | C | C |
| 324 | H | U | C | U | U | U | U |
| 335 | H | C | C | C | U | U | C |
| 341 | H | U | C | C | U | C | C |
| 346 | H | U | U | U | U | U | U |
| 352 | H | C | U | U | U | U | U |
| 361 | H | U | U | U | U | U | U |
| 370 | H | U | U | U | U | U | U |
| 374 | H | U | U | C | U | U | C |
| 377 | H | U | C | U | U | U | U |
| 380 | H | C | U | U | U | U | U |
| 382 | H | U | U | C | ? | ? | ? |
| 383 | H | U | U | C | ? | ? | ? |
| 386 | H | U | C | C | U | U | C |
| 395 | H | C | U | C | U | U | U |
| 398 | H | U | U | C | U | U | U |
| 413 | H | U | U | U | U | U | U |
| 430 | H | U | U | C | U | U | U |
| 445 | H | U | U | U | U | U | U |
| 39 | M | C | U | U | U | U | U |
| 85 | M | C | C | C | U | U | U |
| 144 | M | C | U | U | U | U | U |
| 388 | M | U | U | U | C | U | U |
| 32 | L | C | U | C | U | U | U |
| 365 | L | C | C | C | U | U | U |
| 434 | L | U | U | U | U | U | U |

# Table I20
## Computer Literacy

| Student | Computer Literacy | Document Content | | | Operational Facilities | | |
|---|---|---|---|---|---|---|---|
| | | *Task 1* | *Task 2* | *Task 3* | *Task 1* | *Task 2* | *Task 3* |
| 10 | H | U | U | C | U | U | U |
| 41 | H | U | U | C | U | U | U |
| 46 | H | C | C | C | U | U | U |
| 52 | H | C | C | C | U | U | C |
| 71 | H | U | C | U | U | U | C |
| 85 | H | C | C | C | U | U | U |
| 92 | H | U | U | C | U | U | U |
| 111 | H | C | C | C | U | U | U |
| 116 | H | C | C | C | U | U | U |
| 125 | H | C | U | C | U | U | U |
| 192 | H | U | U | C | C | ? | ? |
| 233 | H | C | C | C | U | U | U |
| 284 | H | U | U | C | ? | ? | ? |
| 286 | H | U | U | C | C | U | C |
| 323 | H | U | U | C | C | C | C |
| 335 | H | C | C | C | U | U | C |
| 341 | H | U | C | C | U | C | C |
| 346 | H | U | U | U | U | U | U |
| 352 | H | C | U | U | U | U | U |
| 361 | H | U | U | U | U | U | U |
| 382 | H | U | U | C | ? | ? | ? |
| 386 | H | U | C | C | U | U | C |
| 430 | H | U | U | C | U | U | U |
| 445 | H | U | U | U | U | U | U |
| 8 | M | U | U | C | U | U | U |
| 39 | M | C | U | U | U | U | U |
| 47 | M | U | C | U | U | U | U |
| 60 | M | C | C | C | U | U | U |
| 82 | M | U | C | C | U | C | U |
| 144 | M | C | U | U | U | U | U |
| 175 | M | U | U | C | U | U | U |
| 199 | M | C | C | C | ? | ? | C |
| 201 | M | C | C | U | ? | C | ? |
| 208 | M | C | C | C | C | ? | C |
| 224 | M | C | C | C | U | U | C |
| 228 | M | U | C | U | U | U | C |
| 244 | M | U | U | C | U | U | C |
| 263 | M | U | U | U | U | U | U |
| 287 | M | U | U | C | ? | C | C |
| 290 | M | U | U | U | U | U | U |
| 324 | M | U | C | U | U | U | U |
| 365 | M | C | C | C | U | U | U |
| 370 | M | U | U | U | U | U | U |
| 374 | M | U | U | C | U | U | C |
| 377 | M | U | C | U | U | U | U |
| 380 | M | C | U | U | U | U | U |
| 383 | M | U | U | C | ? | ? | ? |
| 388 | M | U | U | U | C | U | U |
| 395 | M | C | U | C | U | U | U |
| 398 | M | U | U | C | U | U | U |
| 413 | M | U | U | U | U | U | U |
| 434 | M | U | U | U | U | U | U |
| 32 | L | C | U | C | U | U | U |

Table I21
Search Experience

| Student | Search Experience | Document Content Task 1 | Document Content Task 2 | Document Content Task 3 | Operational Facilities Task 1 | Operational Facilities Task 2 | Operational Facilities Task 3 |
|---|---|---|---|---|---|---|---|
| 41 | H | U | U | C | U | U | U |
| 71 | H | U | C | U | U | U | C |
| 111 | H | C | C | C | U | U | U |
| 201 | H | C | C | U | ? | C | ? |
| 208 | H | C | C | C | C | ? | C |
| 224 | H | C | C | C | U | U | C |
| 228 | H | U | C | U | U | U | C |
| 233 | H | C | C | C | U | U | U |
| 323 | H | U | U | C | C | C | C |
| 341 | H | U | C | C | U | C | C |
| 352 | H | C | U | U | U | U | U |
| 8 | M | U | U | C | U | U | U |
| 10 | M | U | U | C | U | U | U |
| 32 | M | C | U | C | U | U | U |
| 39 | M | C | U | U | U | U | U |
| 46 | M | C | C | C | U | U | U |
| 52 | M | C | C | C | U | U | C |
| 60 | M | C | C | C | U | U | U |
| 82 | M | U | C | C | U | C | U |
| 85 | M | C | C | C | U | U | U |
| 92 | M | U | U | C | U | U | U |
| 116 | M | C | C | C | U | U | U |
| 125 | M | C | U | C | U | U | U |
| 175 | M | U | U | C | U | U | U |
| 192 | M | U | U | C | C | ? | ? |
| 199 | M | C | C | C | ? | ? | C |
| 263 | M | U | U | U | U | U | U |
| 284 | M | U | U | C | ? | ? | ? |
| 286 | M | U | U | C | C | U | C |
| 287 | M | U | U | C | ? | C | C |
| 290 | M | U | U | U | U | U | U |
| 324 | M | U | C | U | U | U | U |
| 335 | M | C | C | C | U | U | C |
| 346 | M | U | U | U | U | U | U |
| 361 | M | U | U | U | U | U | U |
| 365 | M | C | C | C | U | U | U |
| 370 | M | U | U | U | U | U | U |
| 374 | M | U | U | C | U | U | C |
| 377 | M | U | C | U | U | U | U |
| 380 | M | C | U | U | U | U | U |
| 382 | M | U | U | C | ? | ? | ? |
| 383 | M | U | U | C | ? | ? | ? |
| 386 | M | U | C | C | U | U | C |
| 388 | M | U | U | U | C | U | U |
| 395 | M | C | U | C | U | U | U |
| 398 | M | U | U | C | U | U | U |
| 413 | M | U | U | U | U | U | U |
| 430 | M | U | U | C | U | U | U |
| 445 | M | U | U | U | U | U | U |
| 47 | L | U | C | U | U | U | U |
| 144 | L | C | U | U | U | U | U |
| 244 | L | U | U | C | U | U | C |
| 434 | L | U | U | U | U | U | U |

# APPENDIX J

## Summary Statistics

Appendices J.1, J.2 and J.3 provide summary statistics for the following groups.

J.1 Combined learning style groups
J.2 Demographic characteristics (excluding those with low membership)
J.3 Demographic characteristics (combined groups)

Appendix J.4 provides summary statistics for each of the following groups when considering the use of additional operational facilities caused by ELINOR system defects.

- Learning Style (Activists, Reflectors, Theorists and Pragmatists)
- Combined learning style groups (Activists and Pragmatists and; Theorists and Reflectors)
- Demographic characteristics (excluding those with low membership)
- Demographic characteristics (combined groups)

System defects influenced the use of operational facilities in Tasks 1 and 3 only. The use of operational facilities in Task 2 and of documents remained unaffected. Therefore, summary statistics for the number and nature of operational facilities used in Tasks 1 and 3 only are included within J.4.

## J.1 Summary Statistics For The Use Of Documents And Operational Facilities: Combined Learning Style Groups

In each of Tables J1, J2 and J3 the letters A, R, T and P represent the following learning style groups.

A = Activists    P = Pragmatists    R = Reflectors    T = Theorists

Table J1
Number Of Documents Used

| Task 1 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
|---|---|---|---|---|
| A and P | 1.0 | 22 | 2 | 2 |
| R and T | 1.2 | 24 | 4 | 3 |
| Task 2 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
| A and P | 1.2 | 19 | 6 | 3 |
| R and T | 1.3 | 24 | 4 | 5 |
| Task 3 | Mean No. Of Documents Used | No. Of Students Using Between 1 And 5 Documents | No. Of Students Using Between 6 And 10 Documents | Maximum No. Of Documents Used |
| A and P | 4.8 | 17 | 7 | 13 |
| R and T | 5.9 | 14 | 10 | 13 |

Table J2
Number Of Document Types Used

| Task 1 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| A and P | 1.0 | 23 | 1 | 2 |
| R and T | 1.1 | 24 | 4 | 2 |
| Task 2 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
| A and P | 1.0 | 25 | 0 | 1 |
| R and T | 1.0 | 28 | 0 | 1 |
| Task 3 | Mean No. Of Document Types Used | No. Of Students Using Between 1 And 5 Document Types | No. Of Students Using Between 6 And 10 Document Types | Maximum No. Of Document Types Used |
| A and P | 2.2 | 25 | 0 | 4 |
| R and T | 2.5 | 28 | 0 | 4 |

Table J3
Number And Nature Of Operational Facilities Used

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | A and P | 14.3 | 13 | 13 | 5 | 35 | 30 |
| | R and T | 18.5 | 16.5 | 15 | 8 | 38 | 30 |
| Task 2 | A and P | 13.2 | 14 | 14 | 4 | 26 | 22 |
| | R and T | 11.9 | 12 | 6 | 4 | 23 | 19 |
| Task 3 | A and P | 22.8 | 24 | 24 | 7 | 40 | 33 |
| | R and T | 21.9 | 22 | 32 | 4 | 44 | 40 |

## J.2 Summary Statistics For The Use Of Documents And Operational Facilities: Demographic Characteristics (Excluding Groups With Low Membership)

Table J4
Number Of Documents Used

| Task 1 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Males | 1.1 | 33 | 3 | 3 |
| Females | 1.2 | 13 | 3 | 2 |
| Asians | 1.2 | 14 | 4 | 3 |
| Europeans | 1.1 | 31 | 2 | 2 |
| Social Class 1 | 1.3 | 7 | 3 | 2 |
| Social Class 2 | 1.0 | 22 | 1 | 2 |
| Social Class 3 | 1.1 | 16 | 1 | 3 |
| High Computer Affinity | 1.1 | 40 | 5 | 3 |
| High Computer Literacy | 1.1 | 20 | 3 | 3 |
| Moderate Computer Literacy | 1.1 | 25 | 3 | 2 |
| High Search Experience | 1.2 | 9 | 2 | 2 |
| Moderate Search Experience | 1.1 | 35 | 2 | 3 |

| Task 2 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Males | 1.2 | 30 | 7 | 3 |
| Females | 1.4 | 13 | 3 | 5 |
| Asians | 1.1 | 17 | 2 | 2 |
| Europeans | 1.4 | 25 | 8 | 5 |
| Social Class 1 | 1.5 | 8 | 2 | 5 |
| Social Class 2 | 1.25 | 18 | 6 | 2 |
| Social Class 3 | 1.2 | 15 | 2 | 3 |
| High Computer Affinity | 1.3 | 37 | 9 | 5 |
| High Computer Literacy | 1.4 | 19 | 5 | 5 |
| Moderate Computer Literacy | 1.2 | 23 | 5 | 3 |
| High Search Experience | 1.2 | 9 | 2 | 2 |
| Moderate Search Experience | 1.3 | 30 | 8 | 5 |

| Task 3 | Mean No. Of Documents Used | No. Of Students Using Between 1 And 5 Documents | No. Of Students Using Between 6 And 10 Documents | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Males | 6.0 | 18 | 15 | 13 |
| Females | 4.0 | 13 | 2 | 13 |
| Asians | 4.3 | 13 | 5 | 13 |
| Europeans | 6.1 | 17 | 12 | 13 |
| Social Class 1 | 6.3 | 5 | 2 | 13 |
| Social Class 2 | 5.75 | 13 | 9 | 11 |
| Social Class 3 | 4.6 | 11 | 6 | 10 |
| High Computer Affinity | 5.8 | 25 | 16 | 13 |
| High Computer Literacy | 5.0 | 14 | 9 | 11 |
| Moderate Computer Literacy | 5.8 | 16 | 8 | 13 |
| High Search Experience | 4.8 | 8 | 1 | 13 |
| Moderate Search Experience | 5.5 | 21 | 14 | 13 |

Table J5
Number Of Document Types Used

| Task 1 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Males | 1.0 | 34 | 2 | 2 |
| Females | 1.2 | 13 | 3 | 2 |
| Asians | 1.1 | 15 | 3 | 2 |
| Europeans | 1.1 | 31 | 2 | 2 |
| Social Class 1 | 1.3 | 7 | 3 | 2 |
| Social Class 2 | 1.0 | 23 | 0 | 1 |
| Social Class 3 | 1.1 | 16 | 1 | 2 |
| High Computer Affinity | 1.1 | 41 | 4 | 2 |
| High Computer Literacy | 1.1 | 20 | 3 | 2 |
| Moderate Computer Literacy | 1.1 | 26 | 2 | 2 |
| High Search Experience | 1.1 | 10 | 1 | 2 |
| Moderate Search Experience | 1.0 | 35 | 2 | 2 |

| Task 2 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Males | 1.0 | 37 | 0 | 1 |
| Females | 1.0 | 16 | 0 | 1 |
| Asians | 1.0 | 19 | 0 | 1 |
| Europeans | 1.0 | 33 | 0 | 1 |
| Social Class 1 | 1.0 | 10 | 0 | 1 |
| Social Class 2 | 1.0 | 24 | 0 | 1 |
| Social Class 3 | 1.0 | 17 | 0 | 1 |
| High Computer Affinity | 1.0 | 46 | 0 | 1 |
| High Computer Literacy | 1.0 | 24 | 0 | 1 |
| Moderate Computer Literacy | 1.0 | 28 | 0 | 1 |
| High Search Experience | 1.0 | 11 | 0 | 1 |
| Moderate Search Experience | 1.0 | 38 | 0 | 1 |

| Task 3 | Mean No. Of Document Types Used | No. Of Students Using Between 1 And 5 Document Types | No. Of Students Using Between 6 And 10 Document Types | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Males | 2.6 | 37 | 0 | 4 |
| Females | 1.9 | 16 | 0 | 4 |
| Asians | 2.1 | 19 | 0 | 4 |
| Europeans | 2.6 | 33 | 0 | 4 |
| Social Class 1 | 2.5 | 10 | 0 | 4 |
| Social Class 2 | 2.5 | 24 | 0 | 4 |
| Social Class 3 | 2.3 | 17 | 0 | 3 |
| High Computer Affinity | 2.4 | 46 | 0 | 4 |
| High Computer Literacy | 2.3 | 24 | 0 | 4 |
| Moderate Computer Literacy | 2.5 | 28 | 0 | 4 |
| High Search Experience | 2.3 | 11 | 0 | 4 |
| Moderate Search Experience | 2.4 | 38 | 0 | 4 |

Table J6
Number And Nature Of Operational Facilities Used

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | Males | 14.8 | 14 | 17 | 5 | 36 | 31 |
| | Females | 20.6 | 17 | 15 | 10 | 38 | 28 |
| | Asians | 18.3 | 16 | 15 | 5 | 38 | 33 |
| | Europeans | 15.5 | 15 | 15 | 7 | 35 | 28 |
| | Social Class 1 | 18.9 | 16 | 17 | 9 | 38 | 29 |
| | Social Class 2 | 14.2 | 14.5 | 15 | 5 | 24 | 19 |
| | Social Class 3 | 18.5 | 17 | 13 | 8 | 36 | 28 |
| | High Computer Affinity | 16.3 | 15 | 15 | 5 | 38 | 33 |
| | High Computer Literacy | 17.6 | 15.5 | 24 | 5 | 38 | 33 |
| | Moderate Computer Literacy | 15.8 | 15 | 15 | 7 | 35 | 28 |
| | High Search Experience | 17.0 | 15 | 23 | 9 | 38 | 29 |
| | Moderate Search Experience | 16.1 | 15 | 15 | 5 | 36 | 31 |
| Task 2 | Males | 12.0 | 12 | 6 | 4 | 26 | 22 |
| | Females | 13.6 | 13 | 13 | 4 | 23 | 19 |
| | Asians | 10.2 | 9 | 14 | 4 | 22 | 18 |
| | Europeans | 13.9 | 14 | 12 | 5 | 26 | 21 |
| | Social Class 1 | 13.1 | 12.5 | 12 | 6 | 23 | 17 |
| | Social Class 2 | 12.1 | 10.5 | 6 | 4 | 23 | 19 |
| | Social Class 3 | 12.2 | 12 | 13 | 4 | 26 | 22 |
| | High Computer Affinity | 12.4 | 12 | 6 | 4 | 26 | 22 |
| | High Computer Literacy | 11.5 | 10.5 | 6 | 4 | 23 | 19 |
| | Moderate Computer Literacy | 13.3 | 12 | 12 | 4 | 26 | 22 |
| | High Search Experience | 10.5 | 9 | 6 | 6 | 23 | 17 |
| | Moderate Search Experience | 13 | 13 | 10 | 4 | 26 | 22 |
| Task 3 | Males | 21.7 | 22 | 32 | 4 | 35 | 31 |
| | Females | 23.8 | 22 | 13 | 7 | 44 | 37 |
| | Asians | 21.9 | 21 | 18 | 4 | 44 | 40 |
| | Europeans | 22.8 | 23 | 32 | 7 | 40 | 33 |
| | Social Class 1 | 24.1 | 22.5 | 18 | 7 | 44 | 37 |
| | Social Class 2 | 22.4 | 24 | 24 | 7 | 40 | 33 |
| | Social Class 3 | 21.4 | 20 | 32 | 4 | 36 | 32 |
| | High Computer Affinity | 22.2 | 22.5 | 32 | 4 | 44 | 40 |
| | High Computer Literacy | 22.7 | 23 | 12 | 4 | 44 | 40 |
| | Moderate Computer Literacy | 22.1 | 20 | 32 | 7 | 40 | 33 |
| | High Search Experience | 23.1 | 18 | 18 | 13 | 44 | 31 |
| | Moderate Search Experience | 21.7 | 22.5 | 24 | 4 | 40 | 36 |

## J.3 Summary Statistics For The Use Of Documents And Operational Facilities: Demographic Characteristics (Combined Groups)

Table J7
Number Of Documents Used

| Task 1 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Asians and Africans | 1.2 | 15 | 4 | 3 |
| Social Classes 3 and 4 | 1.2 | 17 | 2 | 3 |
| High, Moderate and Low Computer Affinity | 1.1 | 46 | 6 | 3 |
| Moderate and Low Computer Literacy | 1.1 | 26 | 3 | 2 |
| Moderate and Low Search Experience | 1.1 | 37 | 4 | 3 |

| Task 2 | Mean No. Of Documents Used | No. Of Students Using 1 Document | No. Of Students Using More Than 1 Document | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Asians and Africans | 1.1 | 18 | 2 | 2 |
| Social Classes 3 and 4 | 1.2 | 17 | 2 | 3 |
| High, Moderate and Low Computer Affinity | 1.3 | 43 | 10 | 5 |
| Moderate and Low Computer Literacy | 1.2 | 25 | 4 | 2 |
| Moderate and Low Search Experience | 1.3 | 34 | 8 | 5 |

| Task 3 | Mean No. Of Documents Used | No. Of Students Using Between 1 And 5 Documents | No. Of Students Using Between 6 And 10 Documents | Maximum No. Of Documents Used |
|---|---|---|---|---|
| Asians and Africans | 4.2 | 14 | 5 | 13 |
| Social Classes 3 and 4 | 4.4 | 13 | 6 | 10 |
| High, Moderate and Low Computer Affinity | 5.4 | 31 | 17 | 13 |
| Moderate and Low Computer Literacy | 5.7 | 15 | 4 | 13 |
| Moderate and Low Search Experience | 5.5 | 23 | 16 | 13 |

Table J8
Number Of Document Types Used

| Task 1 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Asians and Africans | 1.1 | 16 | 3 | 2 |
| Social Classes 3 and 4 | 1.1 | 17 | 2 | 2 |
| High, Moderate and Low Computer Affinity | 1.1 | 47 | 5 | 2 |
| Moderate and Low Computer Literacy | 1.1 | 27 | 2 | 2 |
| Moderate and Low Search Experience | 1.1 | 37 | 4 | 2 |

| Task 2 | Mean No. Of Document Types Used | No. Of Students Using 1 Document Type | No. Of Students Using More Than 1 Document Type | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Asians and Africans | 1.0 | 20 | 0 | 1 |
| Social Classes 3 and 4 | 1.0 | 19 | 0 | 1 |
| High, Moderate and Low Computer Affinity | 1.0 | 53 | 0 | 1 |
| Moderate and Low Computer Literacy | 1.0 | 29 | 0 | 1 |
| Moderate and Low Search Experience | 1.0 | 42 | 0 | 1 |

| Task 3 | Mean No. Of Document Types Used | No. Of Students Using Between 1 And 5 Document Types | No. Of Students Using Between 6 And 10 Document Types | Maximum No. Of Document Types Used |
|---|---|---|---|---|
| Asians and Africans | 2.1 | 20 | 0 | 4 |
| Social Classes 3 and 4 | 2.2 | 19 | 0 | 3 |
| High, Moderate and Low Computer Affinity | 2.4 | 53 | 0 | 4 |
| Moderate and Low Computer Literacy | 2.5 | 29 | 0 | 4 |
| Moderate and Low Search Experience | 2.4 | 42 | 0 | 4 |

Table J9
Number And Nature Of Operational Facilities Used

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | Asians and Africans | 18.3 | 16 | 23 | 5 | 38 | 33 |
| | Social Classes 3 and 4 | 18.3 | 17 | 10 | 8 | 36 | 28 |
| | High, Moderate and Low Computer Affinity | 16.5 | 15 | 15 | 5 | 38 | 33 |
| | Moderate and Low Computer Literacy | 15.7 | 15 | 15 | 7 | 35 | 28 |
| | Moderate and Low Search Experience | 16.4 | 15 | 17 | 5 | 36 | 31 |
| Task 2 | Asians and Africans | 10.2 | 9.5 | 6 | 4 | 22 | 18 |
| | Social Classes 3 and 4 | 12.7 | 12 | 8 | 4 | 26 | 22 |
| | High, Moderate and Low Computer Affinity | 12.5 | 12 | 6 | 4 | 26 | 22 |
| | Moderate and Low Computer Literacy | 13.3 | 13 | 14 | 4 | 26 | 22 |
| | Moderate and Low Search Experience | 13.0 | 13 | 10 | 4 | 26 | 22 |
| Task 3 | Asians and Africans | 21.6 | 19.5 | 31 | 4 | 44 | 40 |
| | Social Classes 3 and 4 | 21.4 | 20 | 13 | 4 | 36 | 32 |
| | High, Moderate and Low Computer Affinity | 22.3 | 22 | 32 | 4 | 44 | 40 |
| | Moderate and Low Computer Literacy | 22.0 | 20 | 32 | 7 | 40 | 33 |
| | Moderate and Low Search Experience | 22.1 | 23 | 32 | 4 | 40 | 36 |

## J.4 Summary Statistics For The Number And Nature Of Operational Facilities Used When Considering ELINOR System Defects:

Table J10
Learning Style

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | Activists | 15.4 | 14 | 13 | 5 | 35 | 30 |
| | Pragmatists | 14.5 | 13 | 13 | 5 | 35 | 30 |
| | Reflectors | 18.9 | 16 | 16 | 9 | 39 | 30 |
| | Theorists | 18.6 | 16.5 | 16 | 8 | 39 | 31 |
| Task 3 | Activists | 24.9 | 25 | 25 | 7 | 40 | 33 |
| | Pragmatists | 22.9 | 24 | 25 | 7 | 40 | 33 |
| | Reflectors | 20.4 | 19.5 | 18 | 4 | 44 | 40 |
| | Theorists | 21.9 | 22 | 32 | 4 | 44 | 40 |

Table J11
Combined Learning Style Groups

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | A and P | 14.5 | 13 | 13 | 5 | 35 | 30 |
| | R and T | 18.6 | 16.5 | 16 | 8 | 39 | 31 |
| Task 3 | A and P | 22.9 | 24 | 25 | 7 | 40 | 33 |
| | R and T | 21.9 | 22 | 32 | 4 | 44 | 40 |

A = Activists P = Pragmatists R = Reflectors T = Theorists

Table J12
Demographic Characteristics (Excluding Groups With Low Membership)

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | Males | 14.9 | 14 | 17 | 5 | 36 | 31 |
| | Females | 20.8 | 17 | 15 | 10 | 39 | 29 |
| | Asians | 18.4 | 16 | 16 | 5 | 39 | 34 |
| | Europeans | 15.7 | 15 | 15 | 7 | 35 | 28 |
| | Social Class 1 | 19.3 | 16.5 | 12 | 10 | 39 | 29 |
| | Social Class 2 | 14.3 | 14.5 | 15 | 5 | 26 | 21 |
| | Social Class 3 | 18.5 | 17 | 13 | 8 | 36 | 28 |
| | High Computer Affinity | 16.5 | 15 | 16 | 5 | 39 | 34 |
| | High Computer Literacy | 17.8 | 15.5 | 12 | 5 | 39 | 34 |
| | Moderate Computer Literacy | 15.9 | 15 | 15 | 7 | 35 | 28 |
| | High Search Experience | 17.1 | 15 | 23 | 9 | 39 | 30 |
| | Moderate Search Experience | 16.2 | 15 | 15 | 5 | 36 | 31 |
| Task 3 | Males | 21.7 | 22 | 32 | 4 | 35 | 31 |
| | Females | 23.9 | 22 | 21 | 7 | 44 | 37 |
| | Asians | 21.9 | 21 | 18 | 4 | 44 | 40 |
| | Europeans | 22.8 | 23 | 32 | 7 | 40 | 33 |
| | Social Class 1 | 24.1 | 22.5 | 18 | 7 | 44 | 37 |
| | Social Class 2 | 22.4 | 24 | 12 | 7 | 40 | 33 |
| | Social Class 3 | 21.5 | 21 | 21 | 4 | 36 | 32 |
| | High Computer Affinity | 22.2 | 22.5 | 32 | 4 | 44 | 40 |
| | High Computer Literacy | 22.7 | 23 | 12 | 4 | 44 | 40 |
| | Moderate Computer Literacy | 22.1 | 20.5 | 32 | 7 | 40 | 33 |
| | High Search Experience | 23.1 | 18 | 18 | 13 | 44 | 31 |
| | Moderate Search Experience | 21.8 | 22.5 | 12 | 4 | 40 | 36 |

Table J13
Combined Demographic Characteristics (Combined Groups)

| | | Mean | Median | Mode | Minimum | Maximum | Range |
|---|---|---|---|---|---|---|---|
| Task 1 | Asians and Africans | 18.4 | 16 | 16 | 5 | 39 | 34 |
| | Social Classes 3 and 4 | 18.3 | 17 | 13 | 8 | 36 | 28 |
| | High, Moderate and Low Computer Affinity | 16.5 | 15 | 15 | 5 | 38 | 33 |
| | Moderate and Low Computer Literacy | 15.8 | 15 | 15 | 7 | 35 | 28 |
| | Moderate and Low Search Experience | 16.6 | 15 | 10 | 5 | 36 | 31 |
| Task 3 | Asians and Africans | 21.6 | 19.5 | 18 | 4 | 44 | 40 |
| | Social Classes 3 and 4 | 21.4 | 21 | 21 | 4 | 36 | 32 |
| | High, Moderate and Low Computer Affinity | 22.3 | 22 | 32 | 4 | 44 | 40 |
| | Moderate and Low Computer Literacy | 22.1 | 21 | 32 | 7 | 40 | 33 |
| | Moderate and Low Search Experience | 22.2 | 23 | 32 | 4 | 40 | 36 |

# APPENDIX K

## Confidence Intervals

The confidence intervals within this appendix represent the range of feasible values within which the population means for the number and nature of documents and operational facilities used are likely to fall. Confidence intervals were calculated at the 95% level throughout the analysis. Appendices K.1 to K.12 provide confidence intervals for the following groups regarding the number and nature of documents and operational facilities used.

K.1 Learning Style: Combined Groups

Demographic Groups
(Excluding Groups With Low Membership):

K.2 Gender
K.3 Ethnic Origin
K.4 Social Class
K.5 Computer Affinity
K.6 Computer Literacy
K.7 Search Experience

Demographic Groups
(Combined):

K.8 Ethnic Origin
K.9 Social Class
K.10 Computer Affinity
K.11 Computer Literacy
K.12 Search Experience

Appendix K.13 provides confidence intervals for each of the above groups when considering the use of additional operational facilities caused by ELINOR system defects. Intervals for individual learning style groups (i.e. Activists, Reflectors, Theorists and Pragmatists) are also provided. System defects influenced the use of operational facilities in Tasks 1 and 3. The use of operational facilities in Task 2 and of documents remained unaffected. Therefore, confidence intervals for the number and nature of operational facilities used in Tasks 1 and 3 only are included within K.13.

## K.1 Combined Learning Style Groups

In each of Figures K1, K2 and K3, the following key applies:

A = Activists, P = Pragmatists, R = Reflectors and T = Theorists

Figure K1
Number Of Documents Used

Task 1 Task 2 Task 3

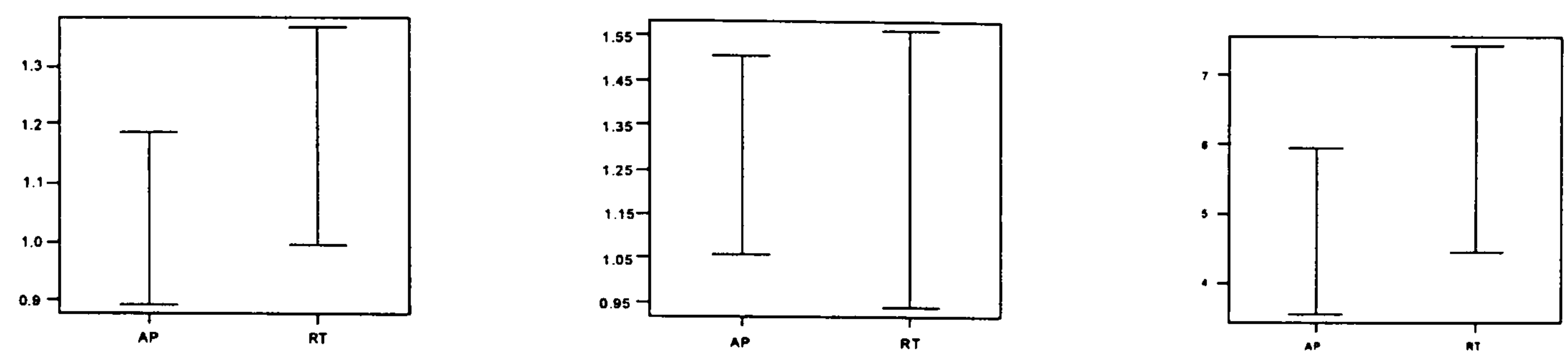



Figure K2
Number Of Document Types Used

Task 1 Task 2 Task 3

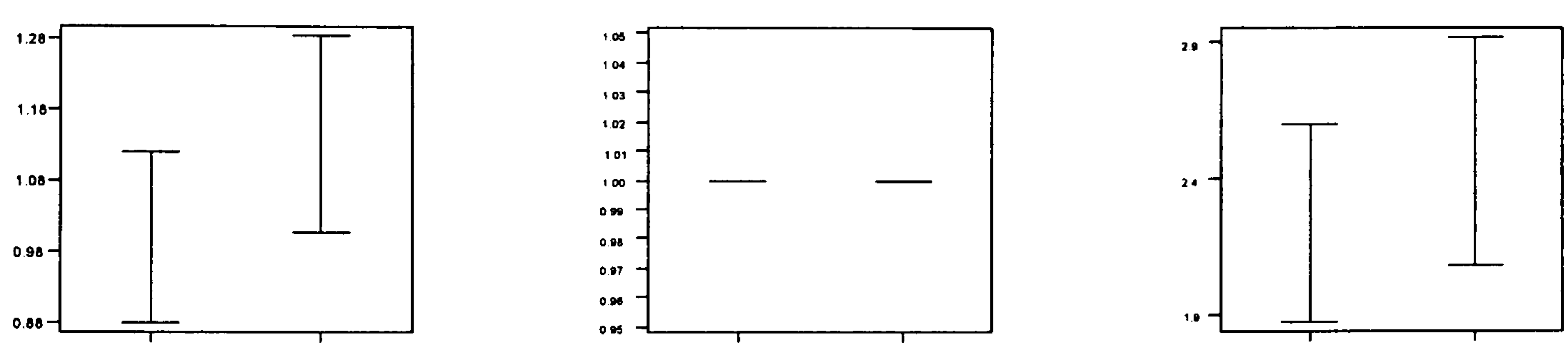
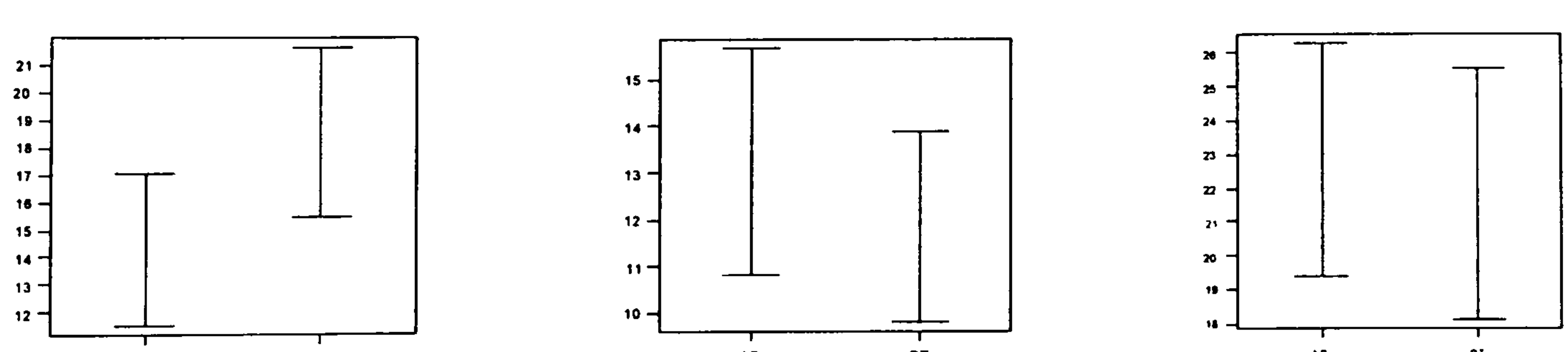



Figure K3
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



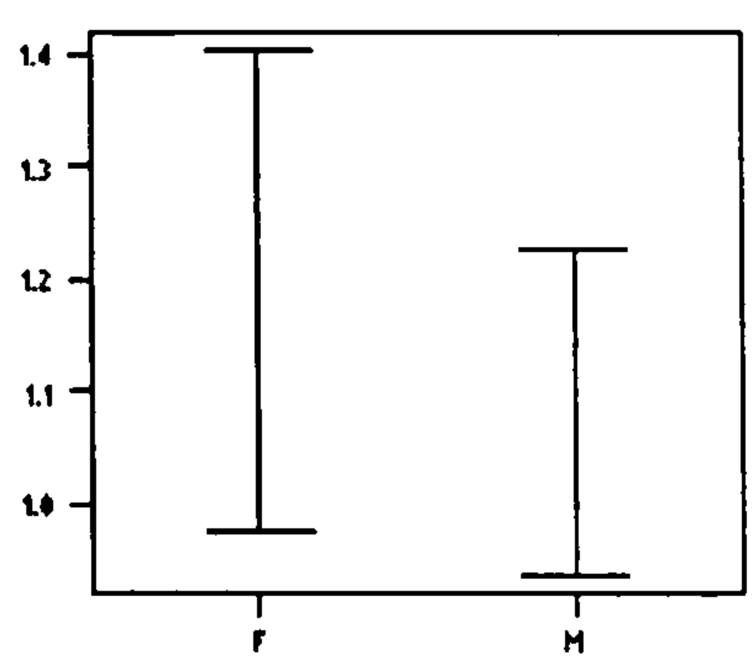
## K.2 Gender

In each of Figures K4, K5 and K6, the following key applies:

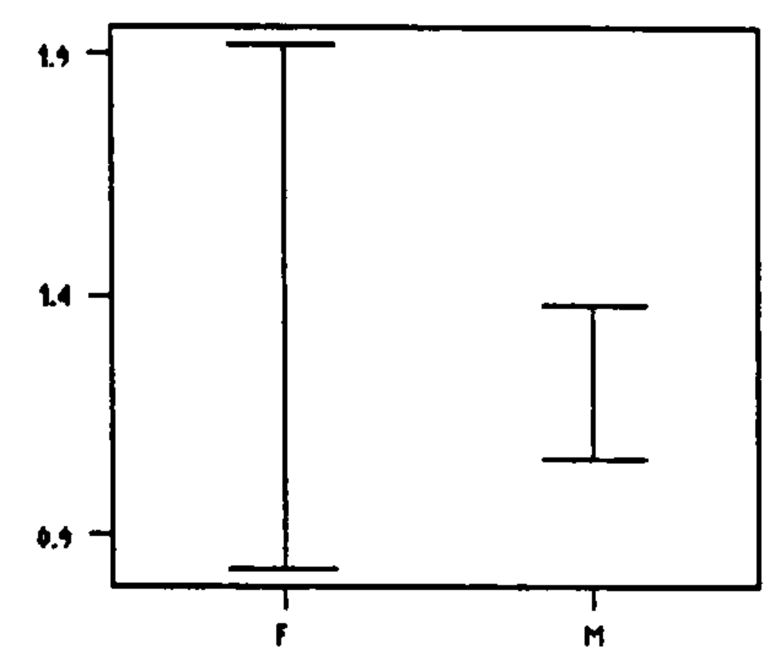
F = Females and M = Males

Figure K4
Number Of Documents Used

Task 1




Task 2




Task 3

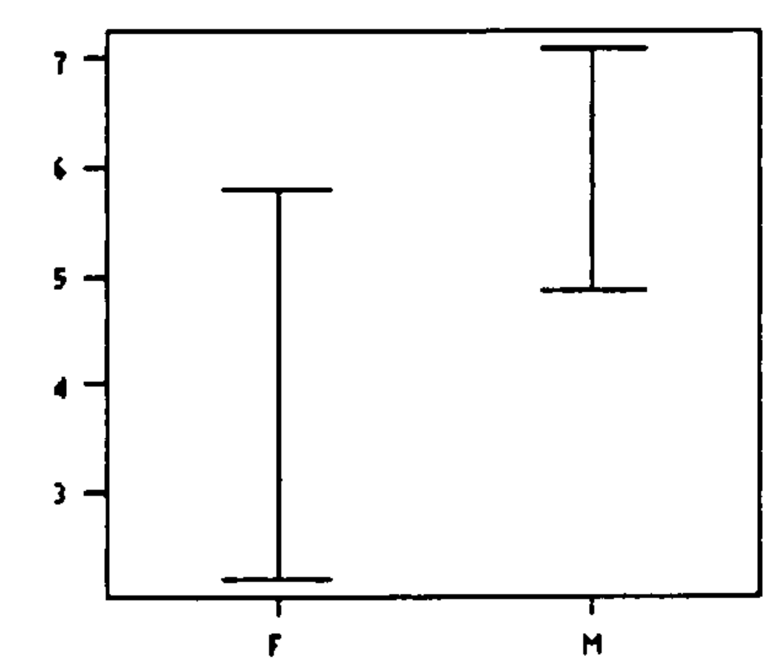
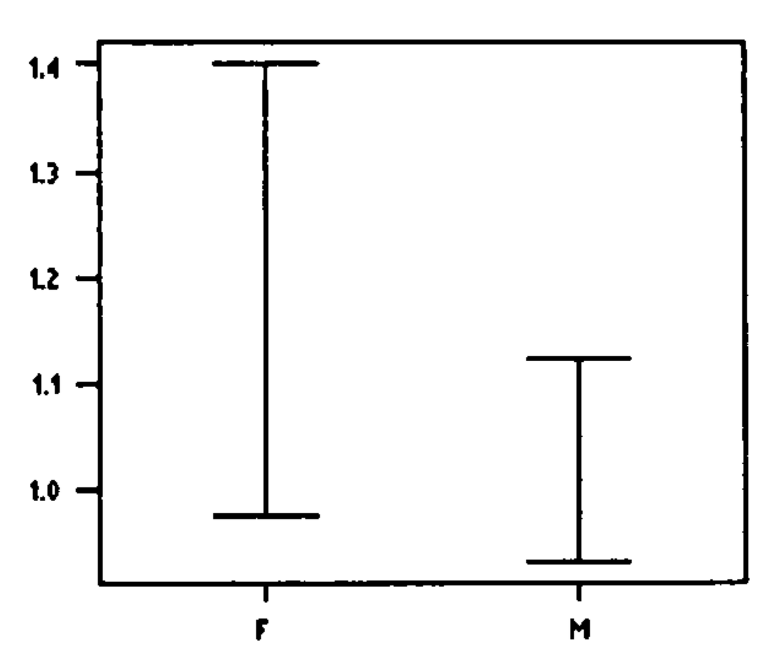
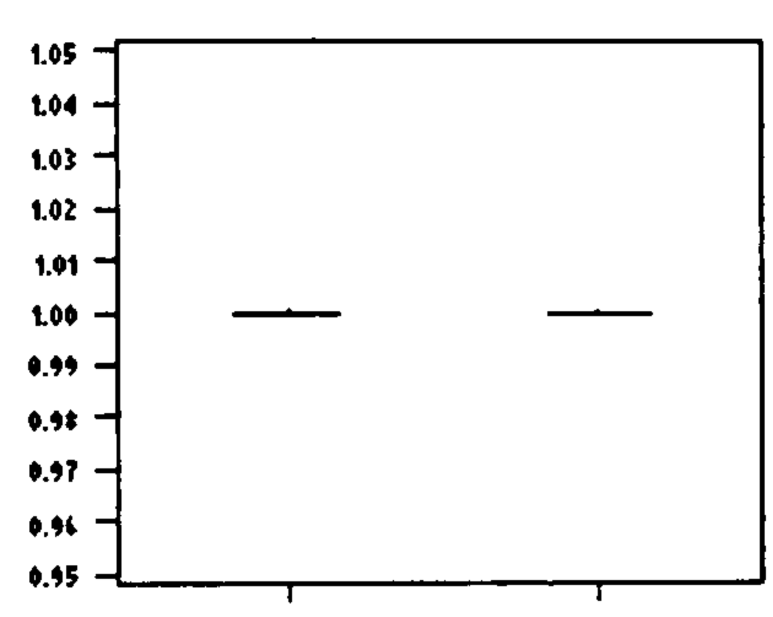



Figure K5
Number Of Document Types Used

Task 1




Task 2




Task 3

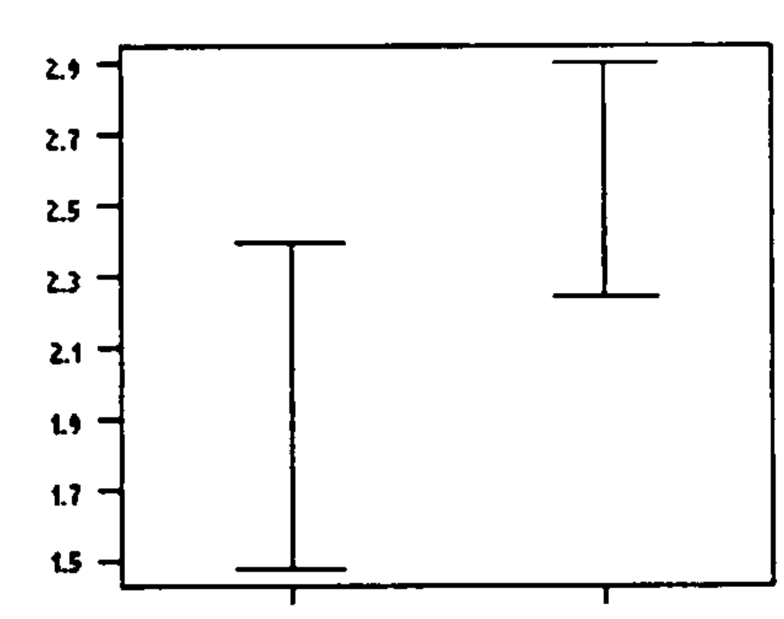
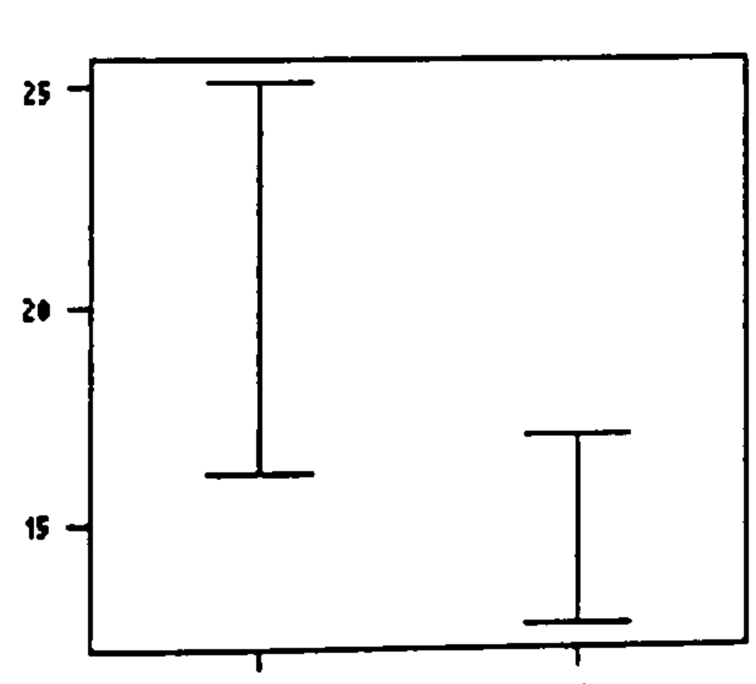
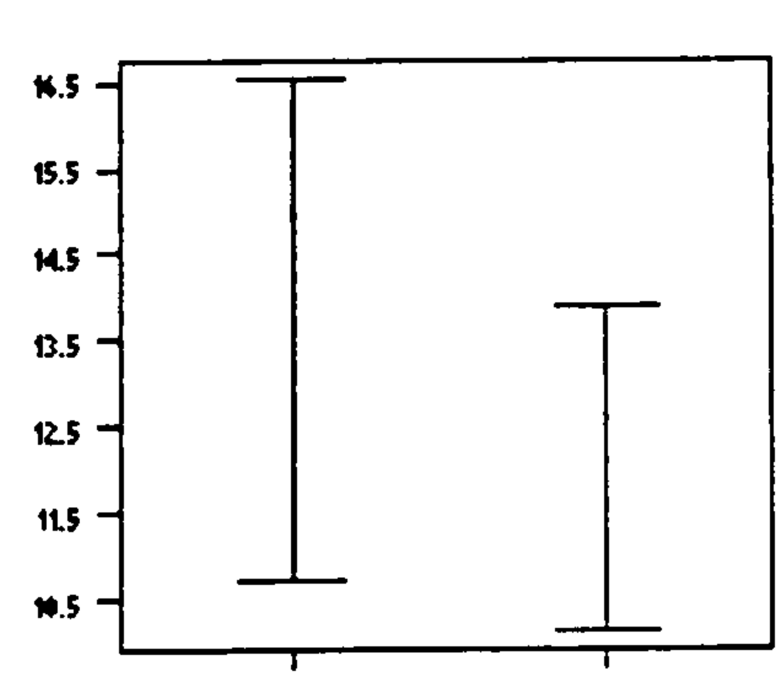



Figure K6
Number And Nature Of Operational Facilities Used

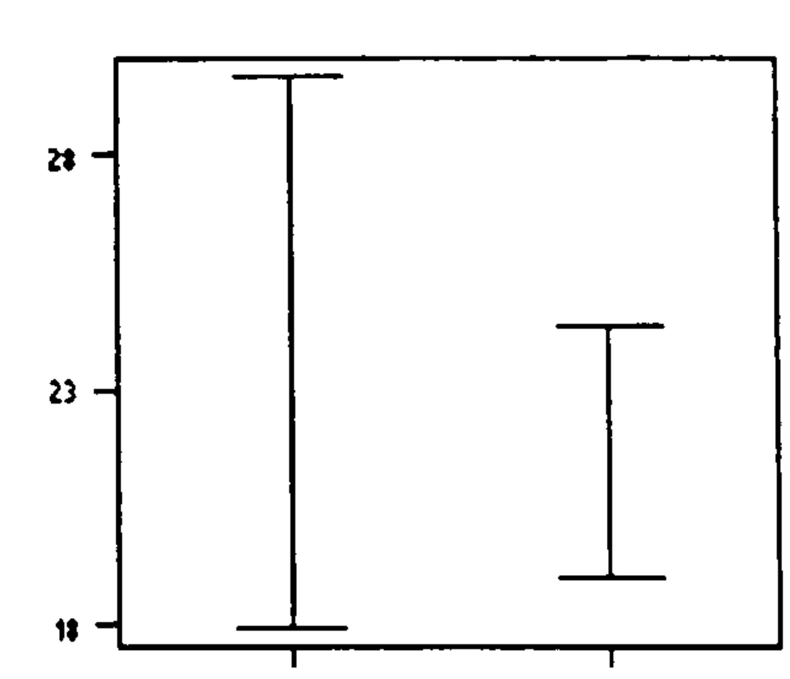
Task 1




Task 2




Task 3



## K.3 Ethnic Origin

In each of Figures K7, K8 and K9, the following key applies:

A = Asians and E = Europeans

Figure K7
Number Of Documents Used

Task 1 Task 2 Task 3

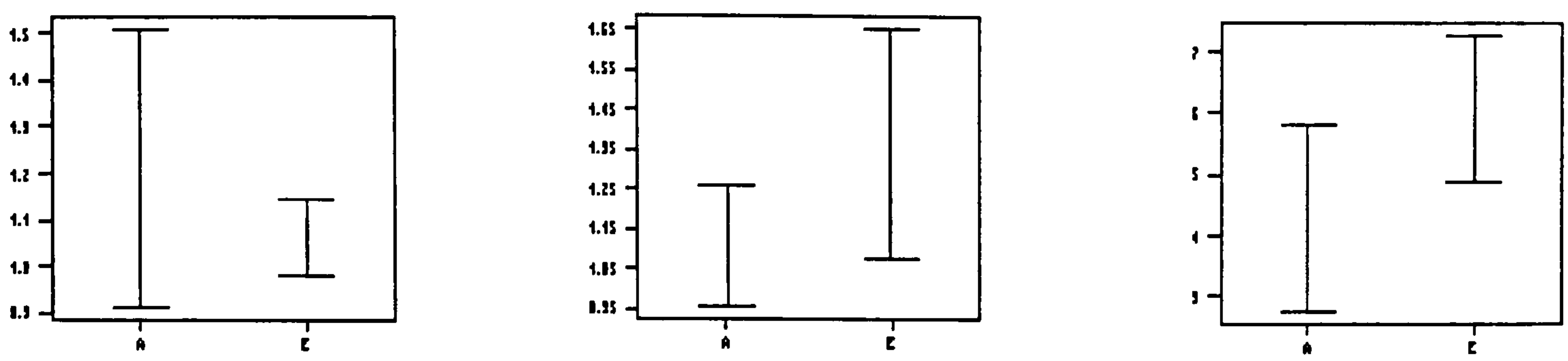


Figure K8
Number Of Document Types Used

Task 1 Task 2 Task 3

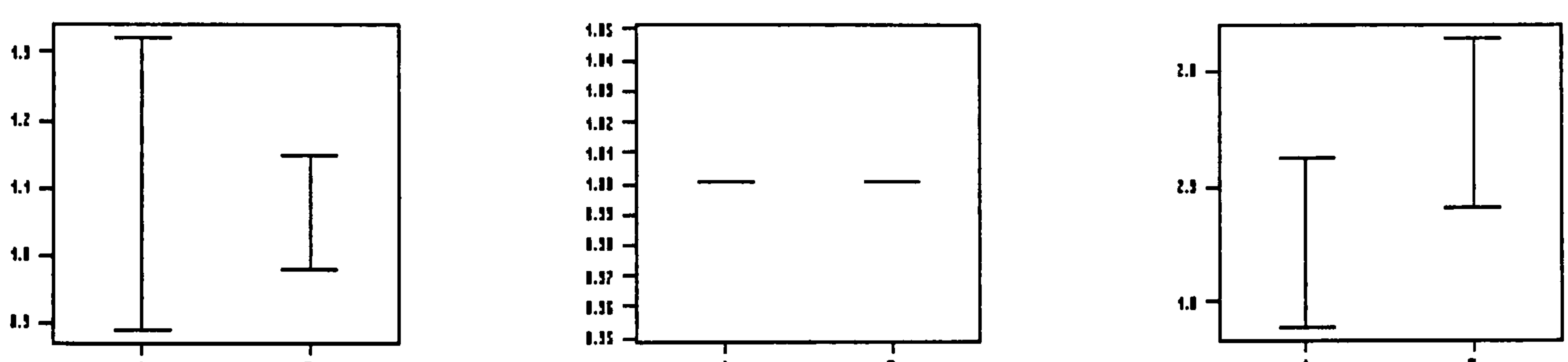
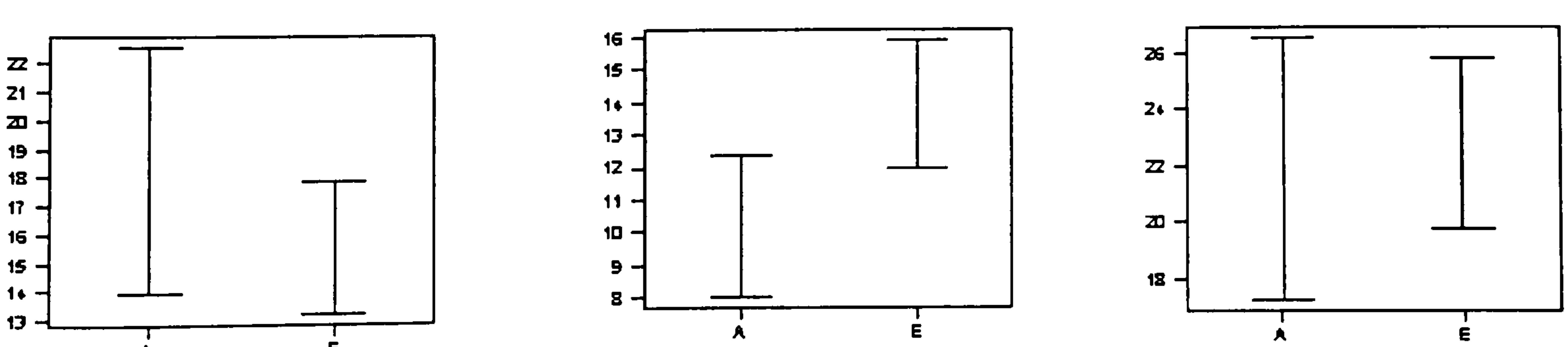


Figure K9
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



## K.4 Social Class

In each of Figures K10, K11 and K12, the confidence intervals for social classes 1, 2, 3 are represented by the corresponding number.

Figure K10
Number Of Documents Used

Task 1 Task 2 Task 3

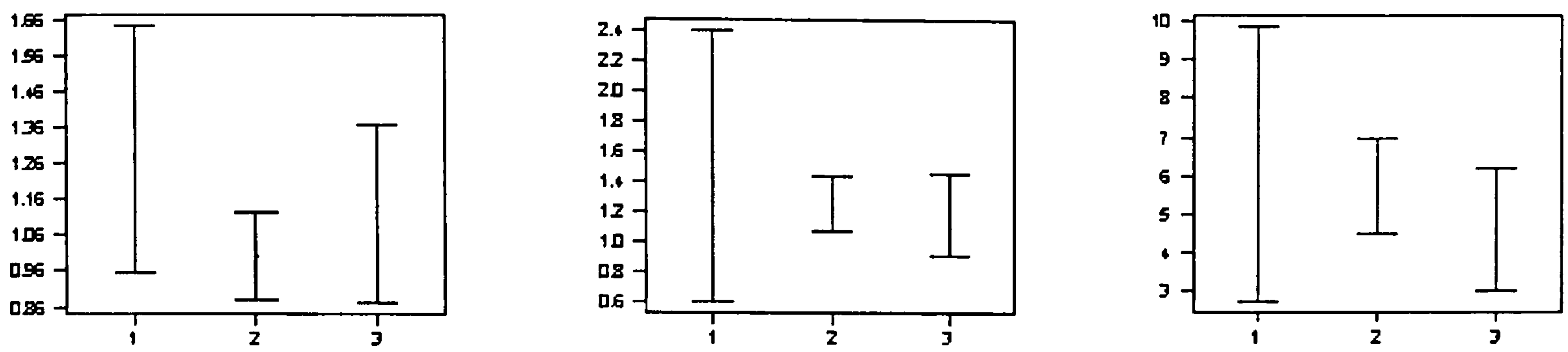



Figure K11
Number Of Document Types Used

Task 1 Task 2 Task 3

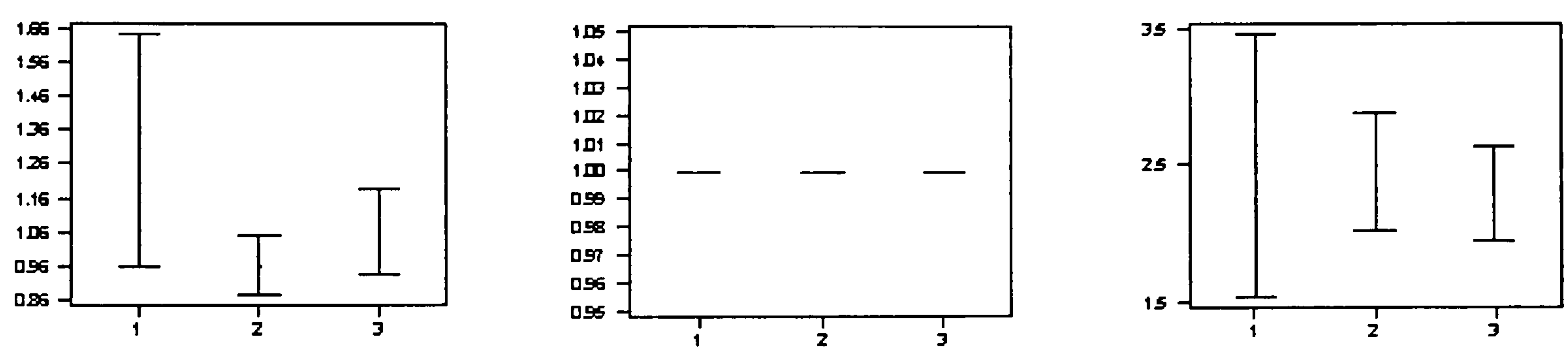
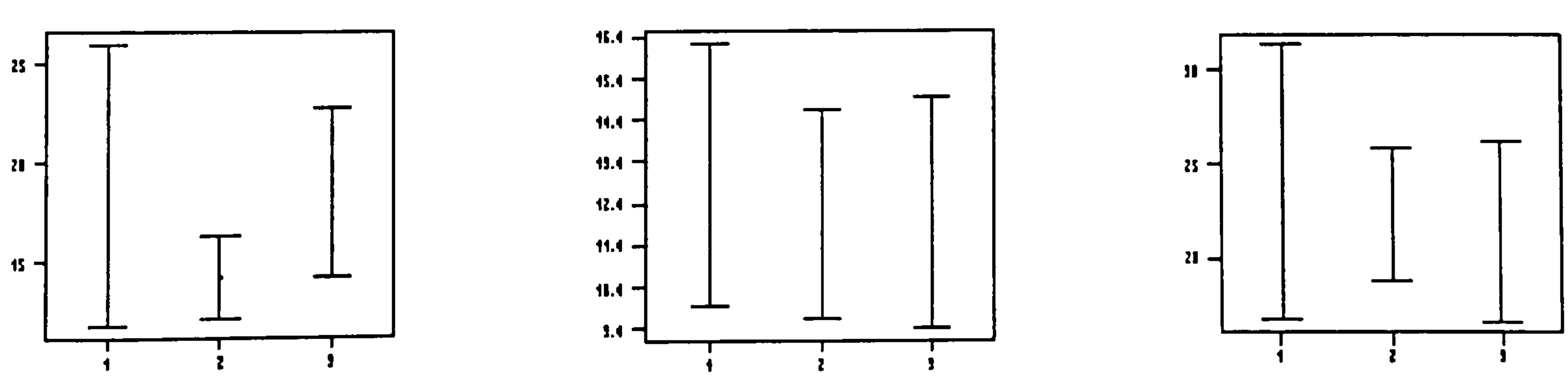



Figure K12
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



## K.5 Computer Affinity

In each of Figures K13, K14 and K15, the following key applies:

H = High

Figure K13
Number Of Documents Used

Task 1 Task 2 Task 3

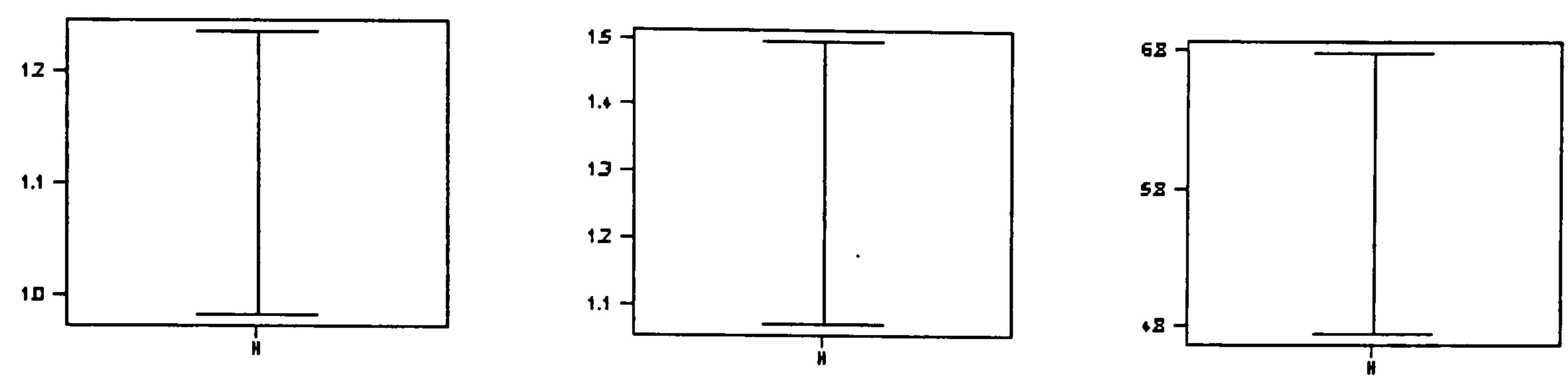



Figure K14
Number Of Document Types Used

Task 1 Task 2 Task 3

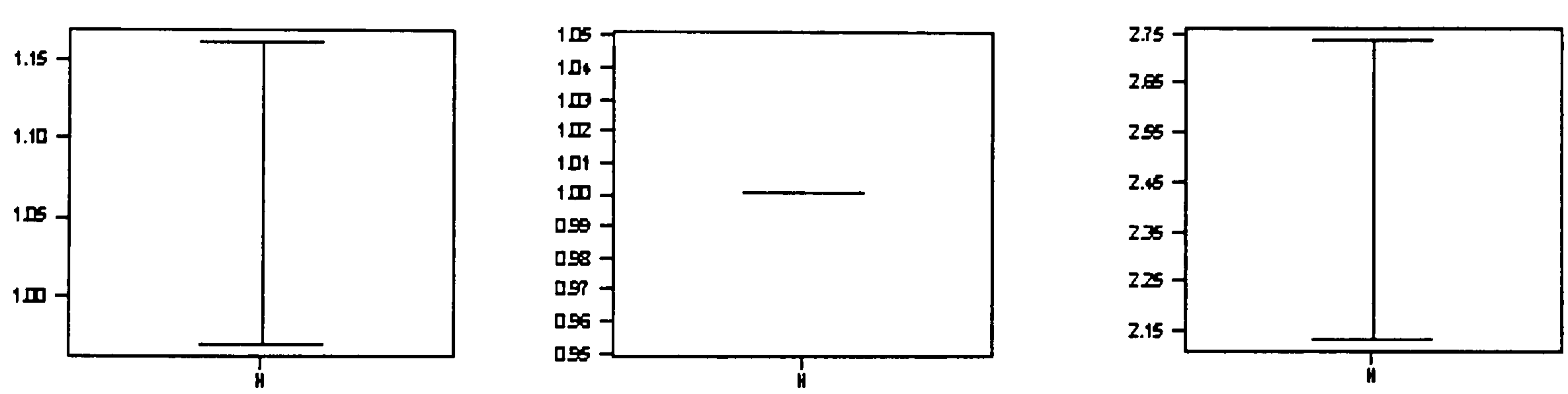
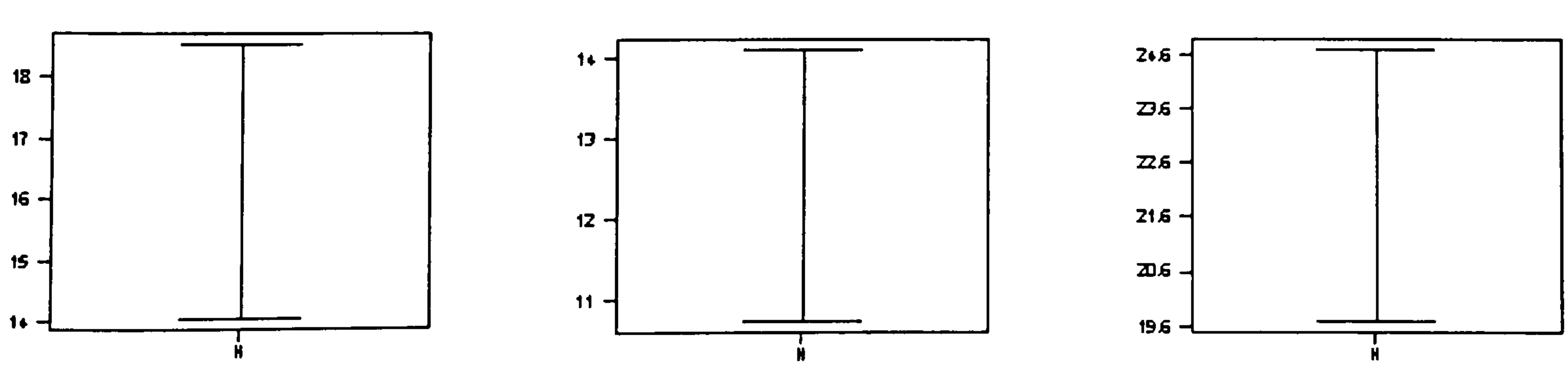



Figure K15
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



## K.6 Computer Literacy

In each of Figures K16, K17 and K18, the following key applies:

H = High and M = Moderate

Figure K16
Number Of Documents Used

Task 1 Task 2 Task 3

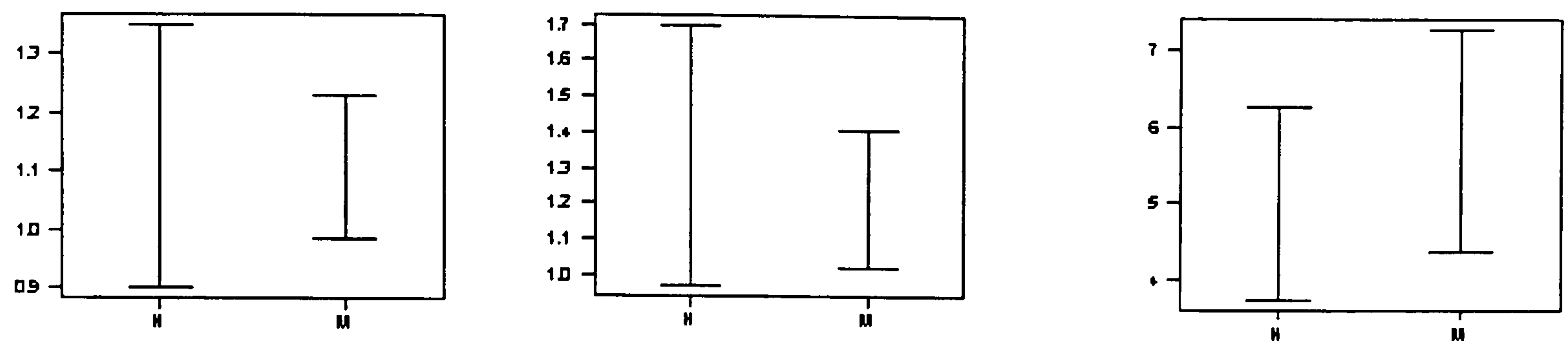



Figure K17
Number Of Document Types Used

Task 1 Task 2 Task 3

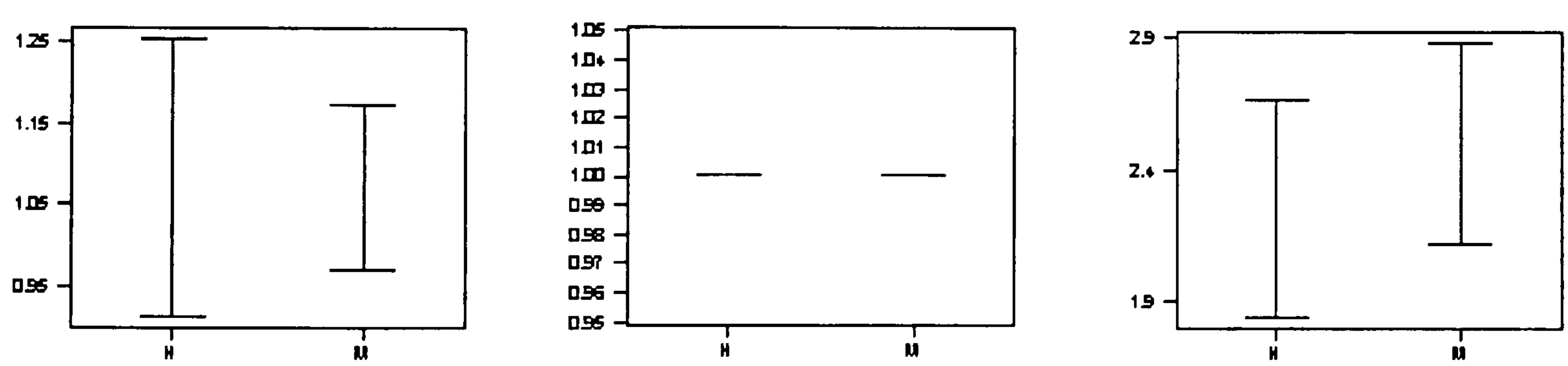
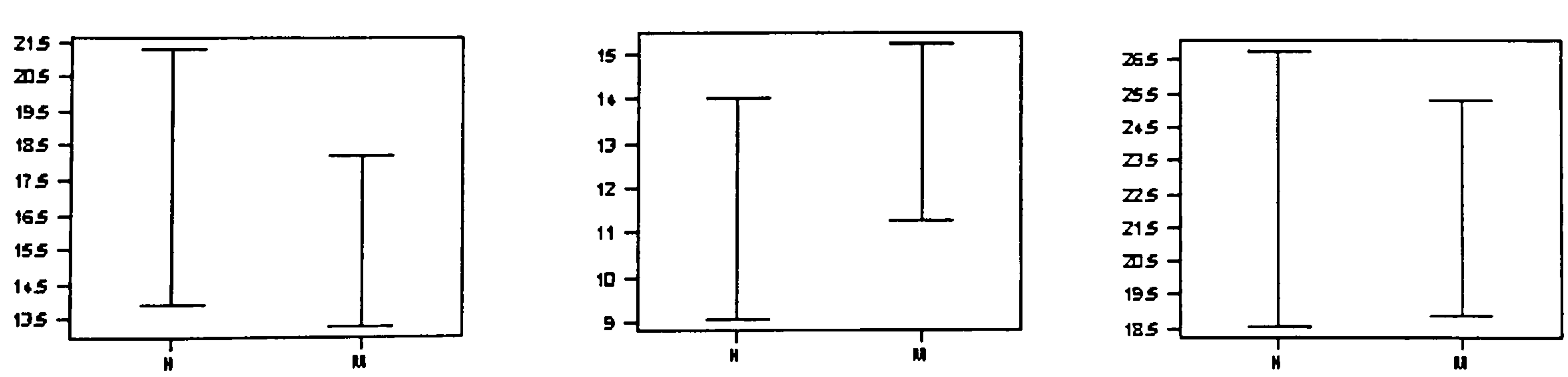



Figure K18
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



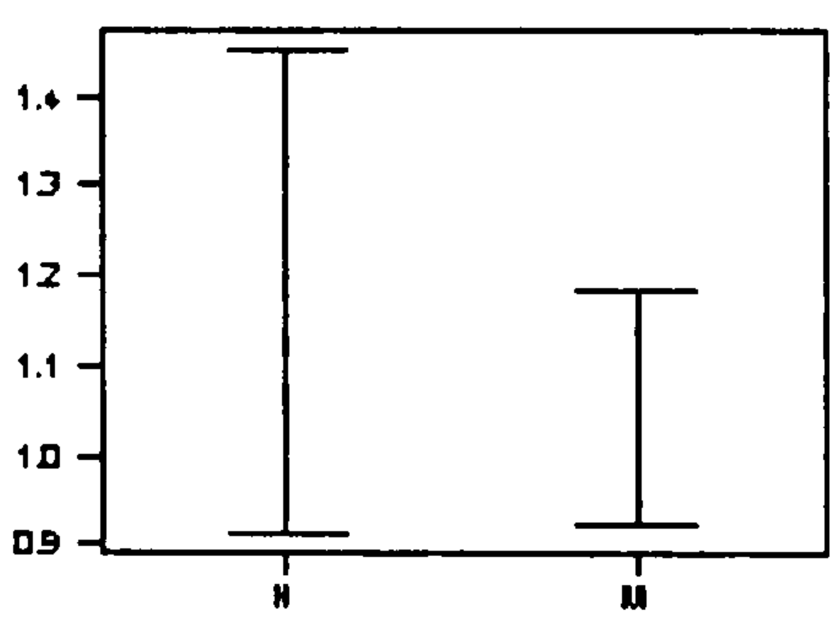
## K.7 Search Experience

In each of Figures K19, K20 and K21, the following key applies:

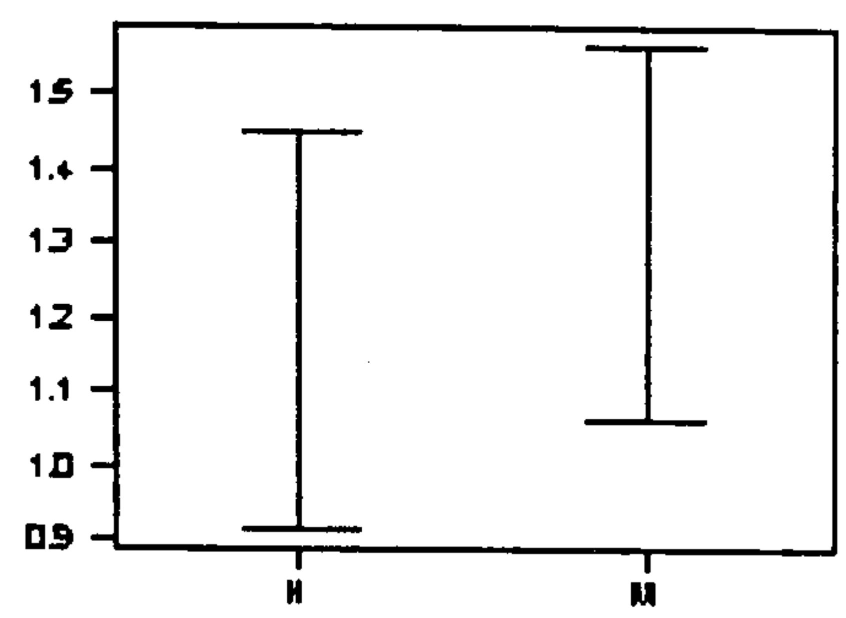
H = High and M = Moderate

Figure K19
Number Of Documents Used

Task 1




Task 2




Task 3

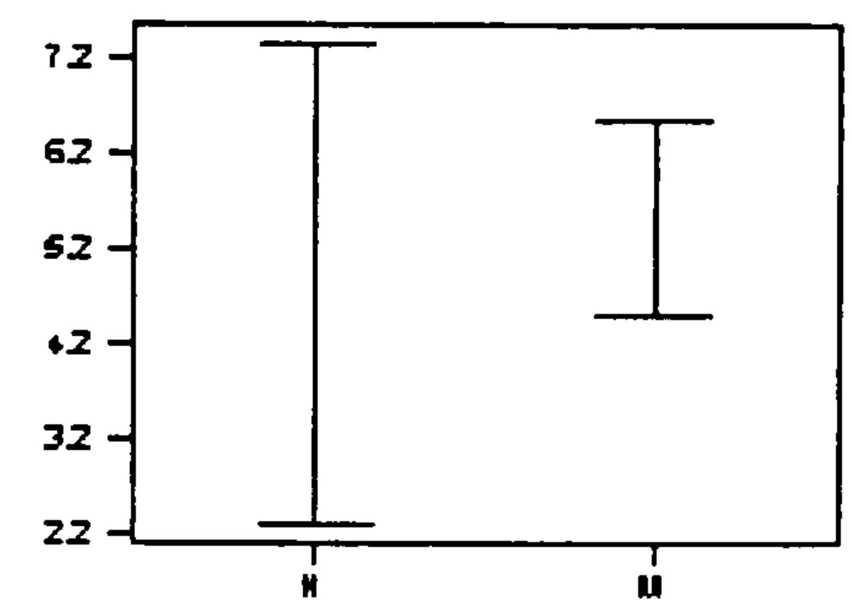
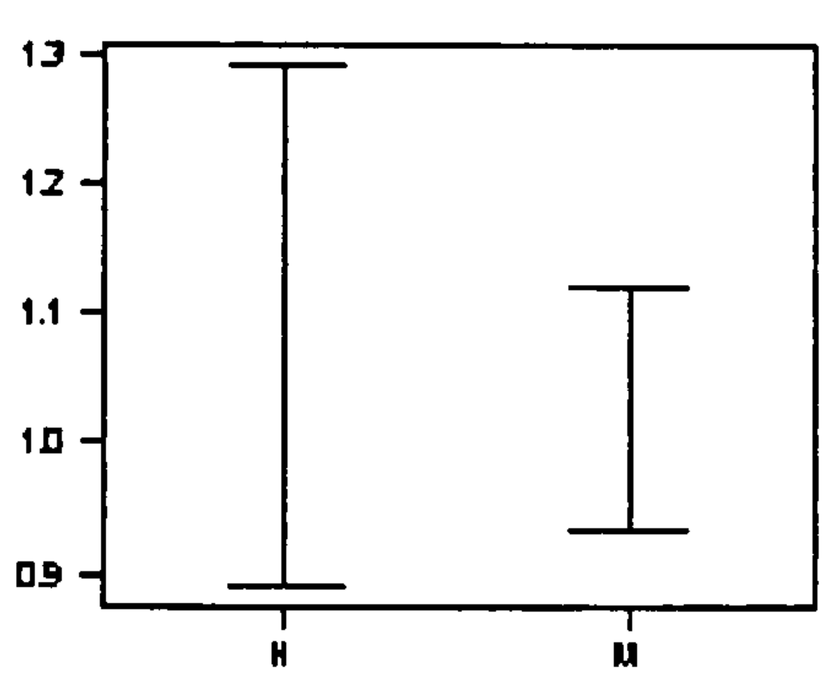
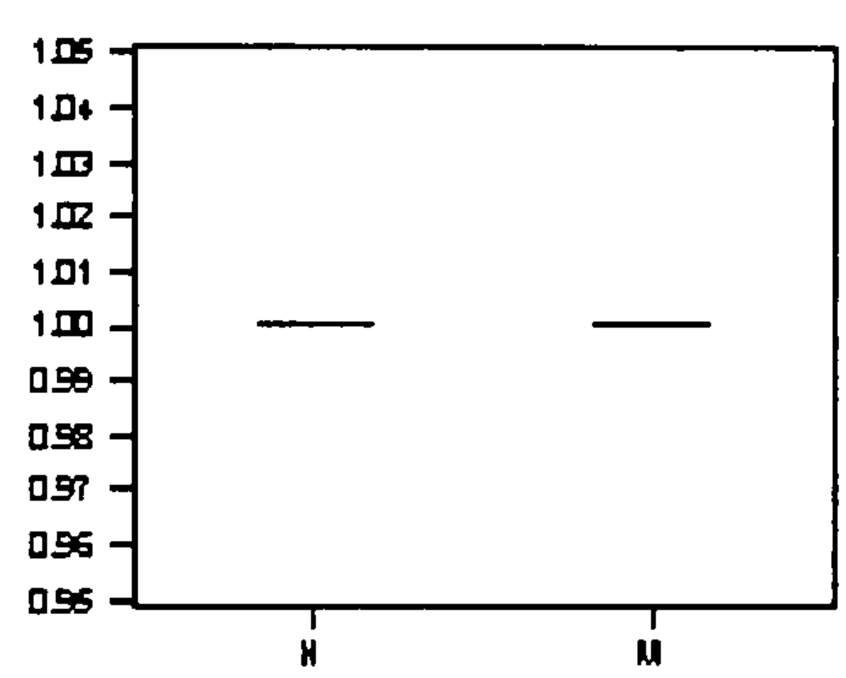



Figure K20
Number Of Document Types Used

Task 1




Task 2




Task 3

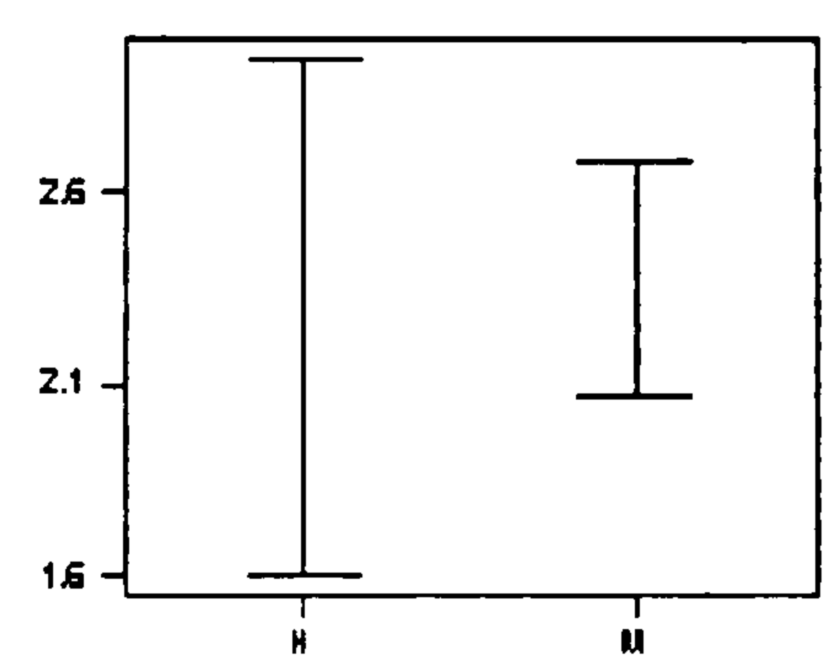
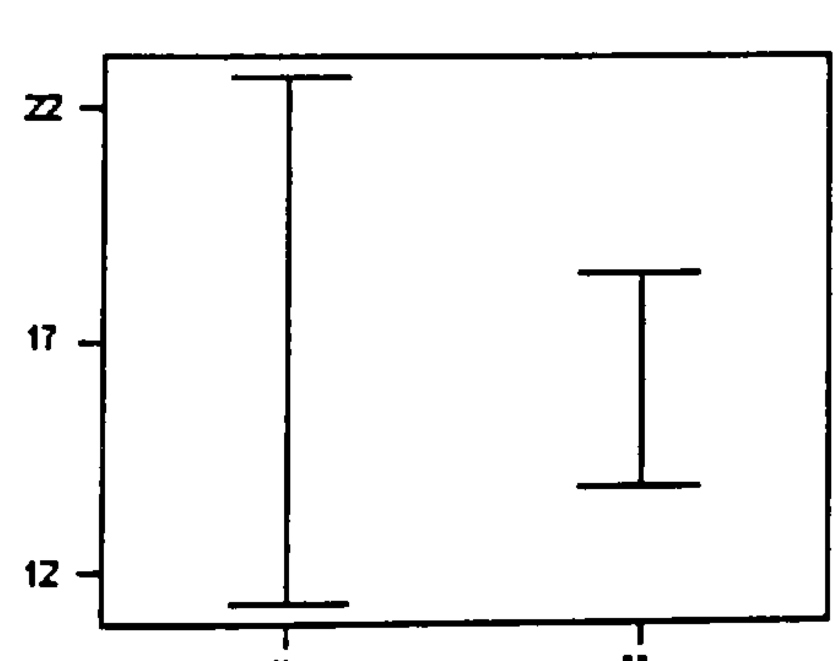
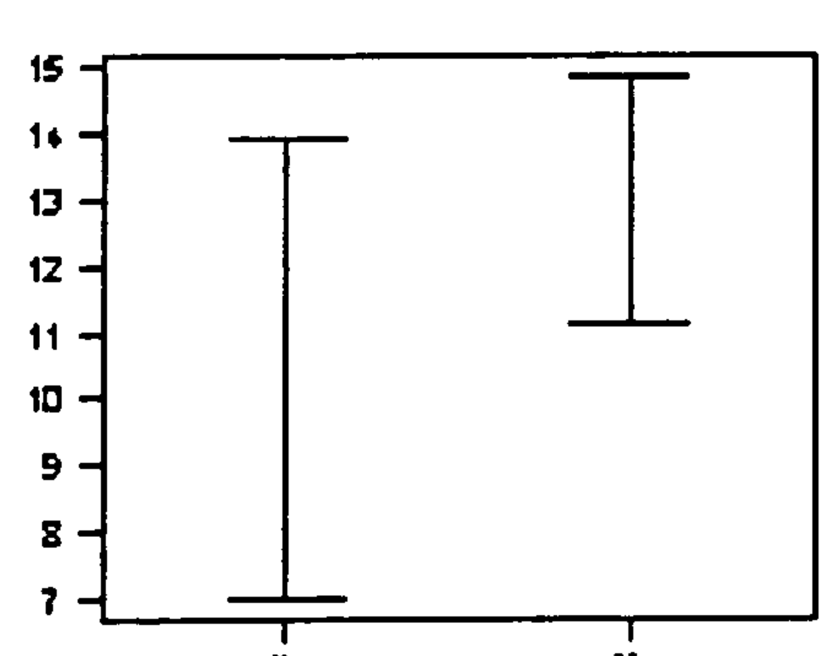



Figure K21
Number And Nature Of Operational Facilities Used

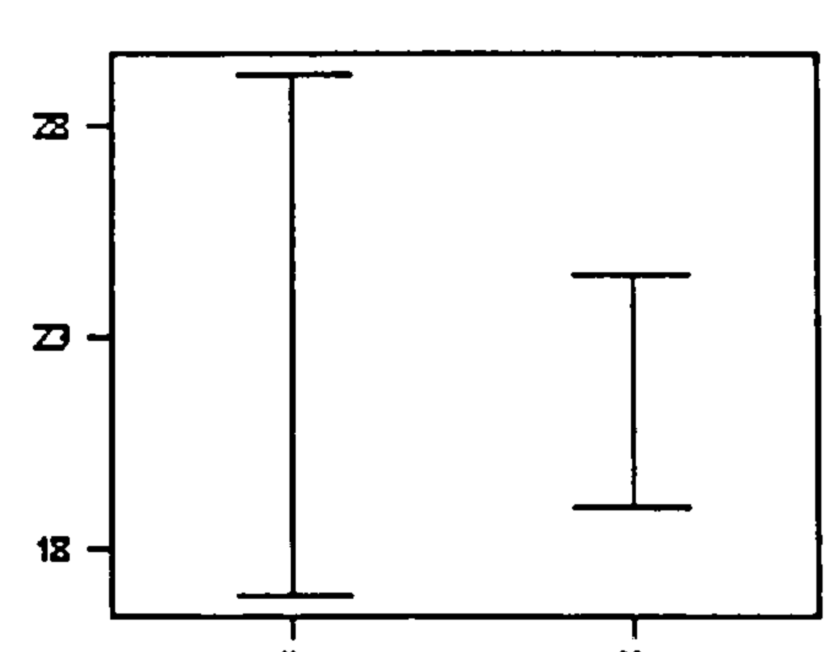
Task 1




Task 2




Task 3



## K.8 Combined Groups: Ethnic Origin

In each of Figures K22, K23 and K24, the following key applies:

A = Asians and Africans; E = Europeans

Figure K22
Number Of Documents Used

Task 1 Task 2 Task 3

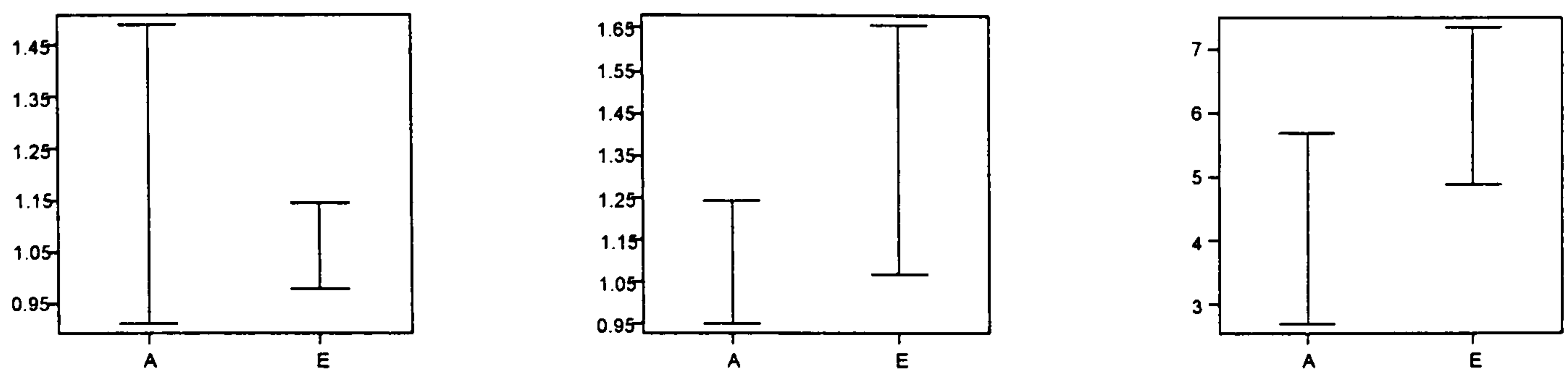



Figure K23
Number Of Document Types Used

Task 1 Task 2 Task 3

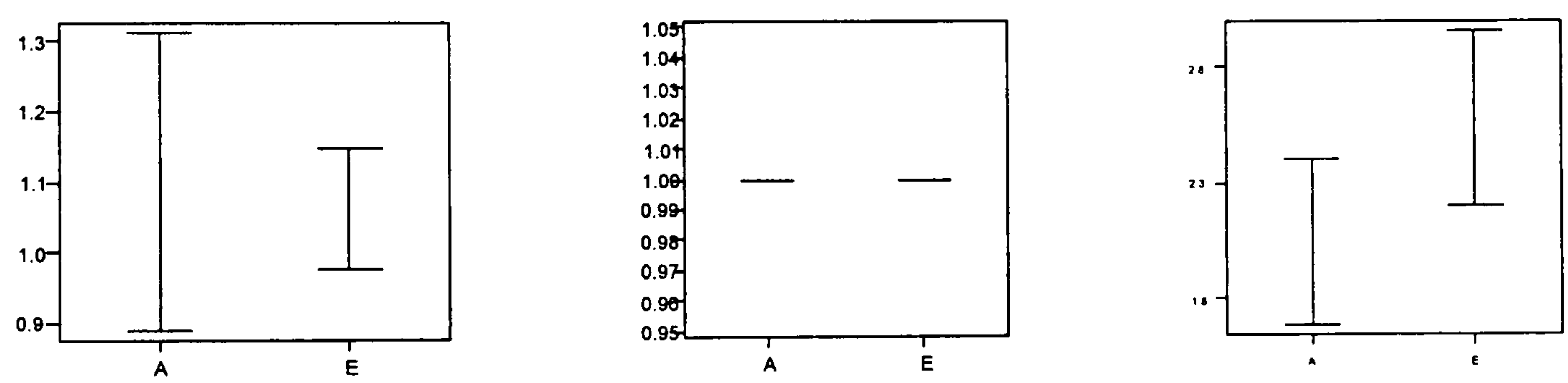
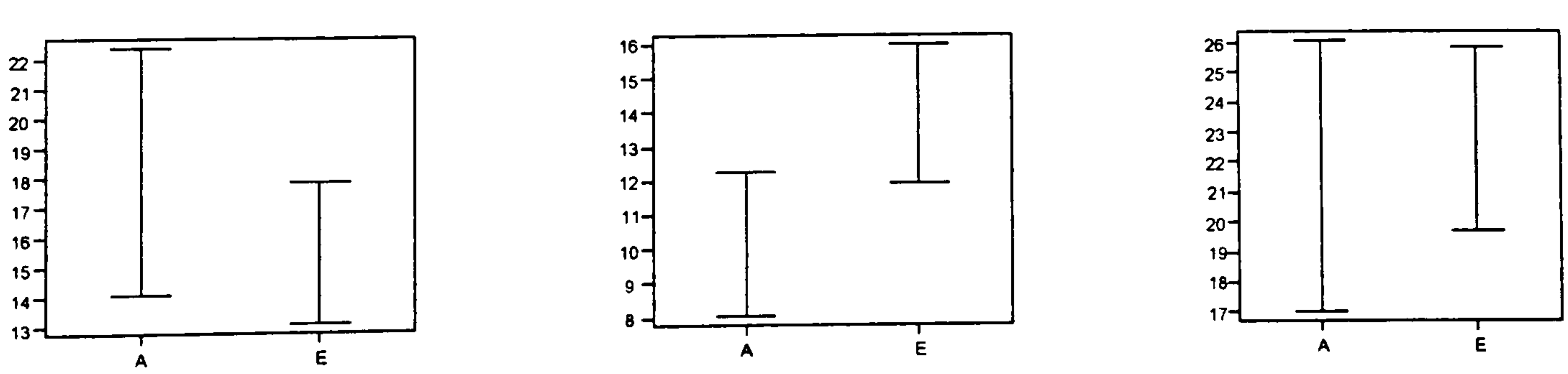



Figure K24
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



## K.9 Combined Groups: Social Class

In each of Figures K25, K26 and K27, the confidence intervals for social classes 1 and 2 are represented by the corresponding number. Confidence intervals for combined social classes 3 and 4 are denoted by the number 3.

Figure K25
Number Of Documents Used

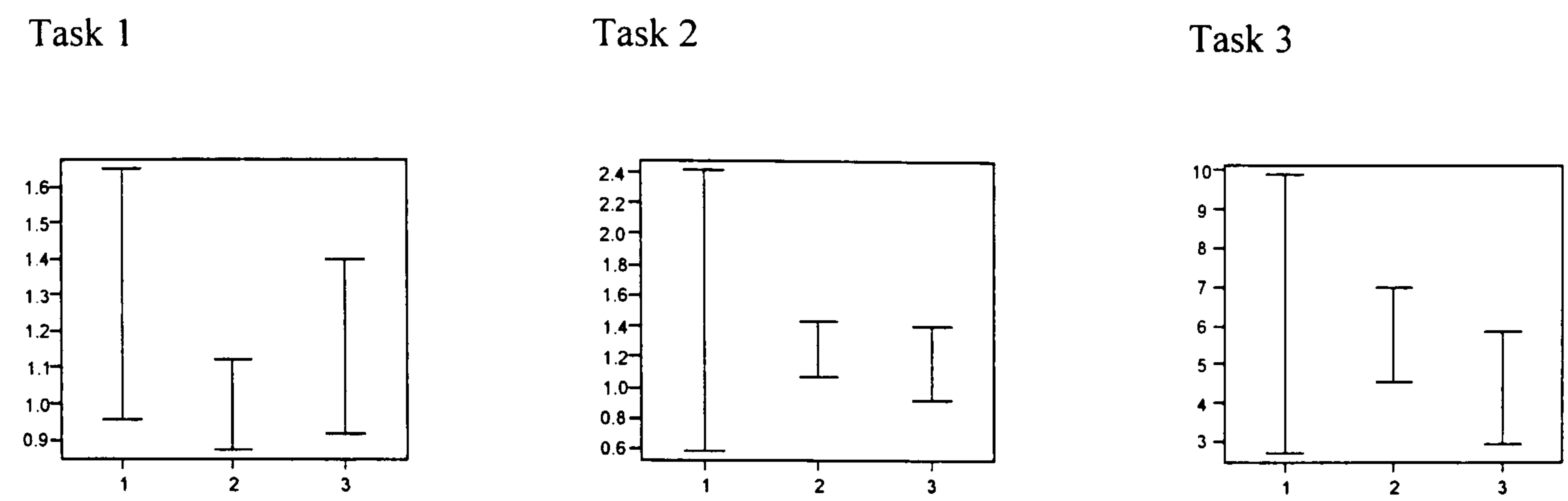



Figure K26
Number Of Document Types Used

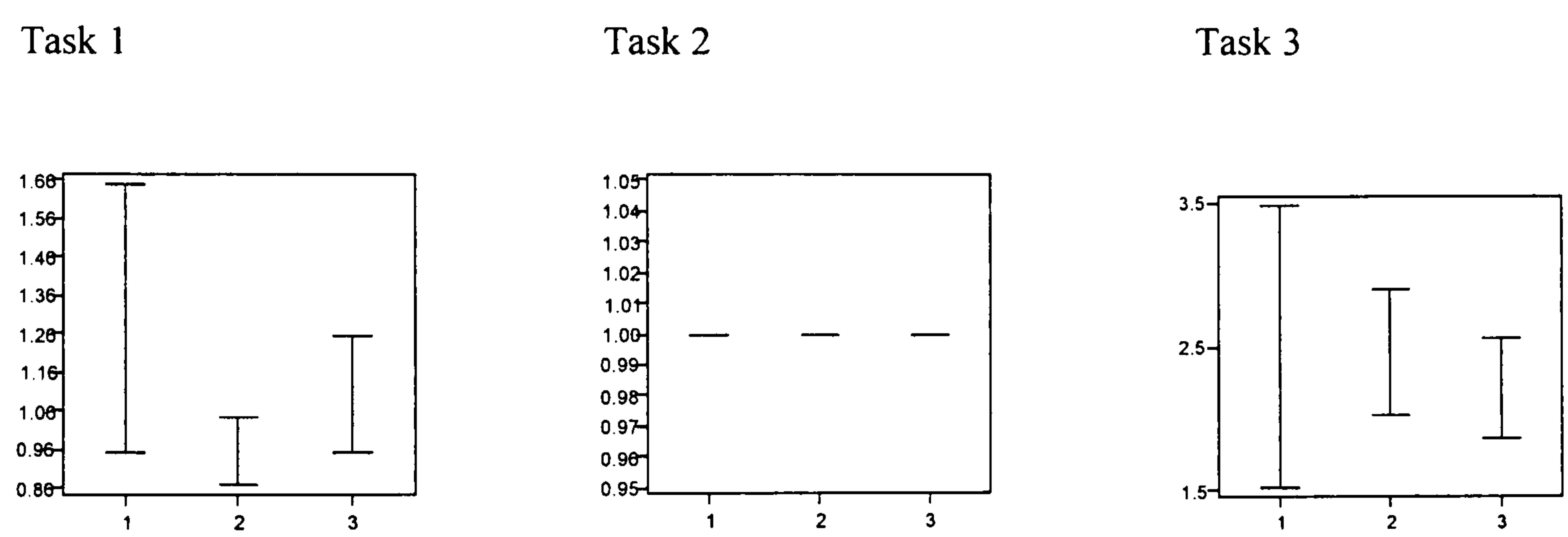
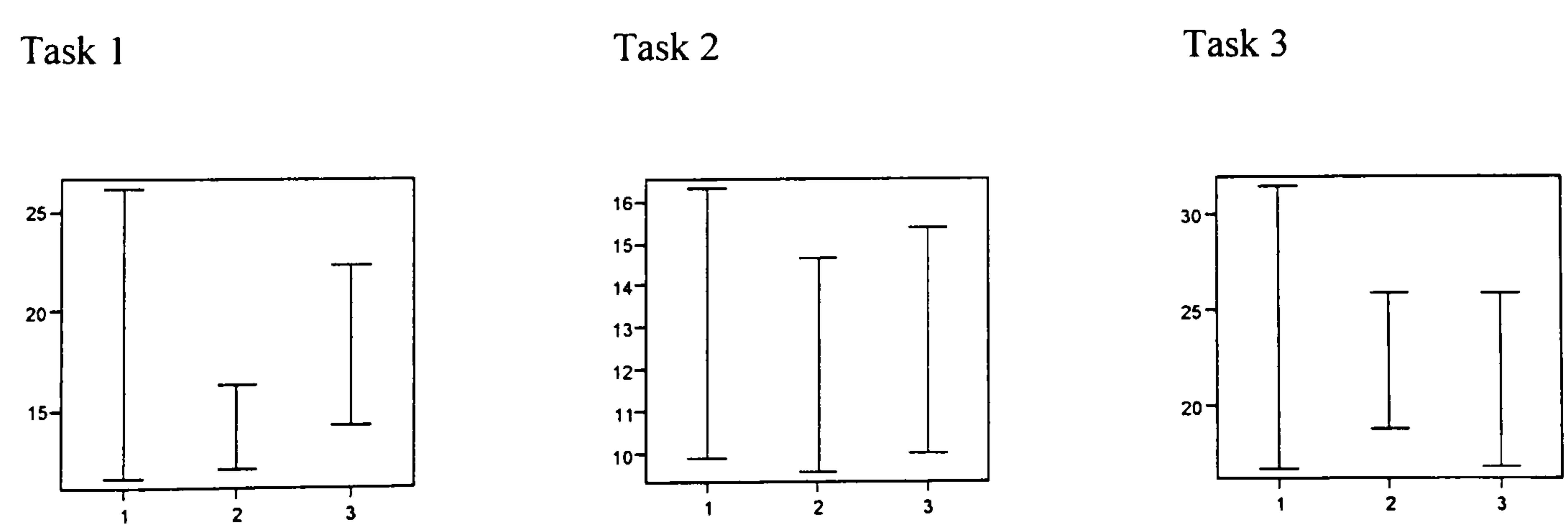



Figure K27
Number And Nature Of Operational Facilities Used



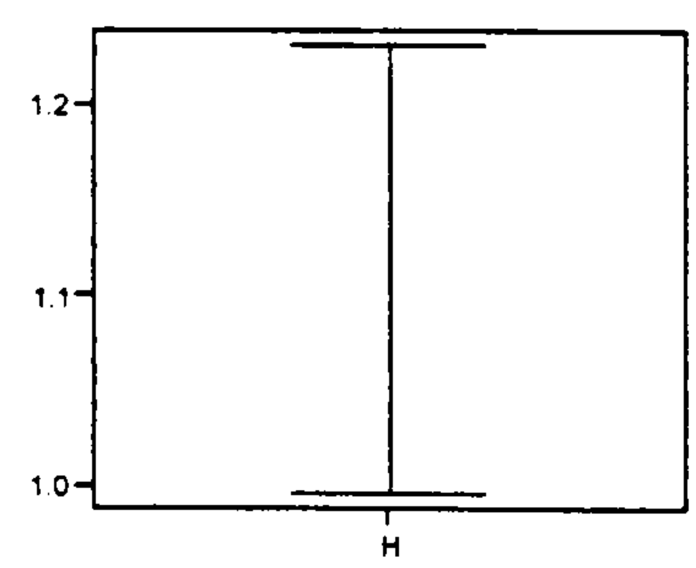
## K.10 Combined Groups: Computer Affinity

In each of Figures K28, K29 and K30, the following key applies:

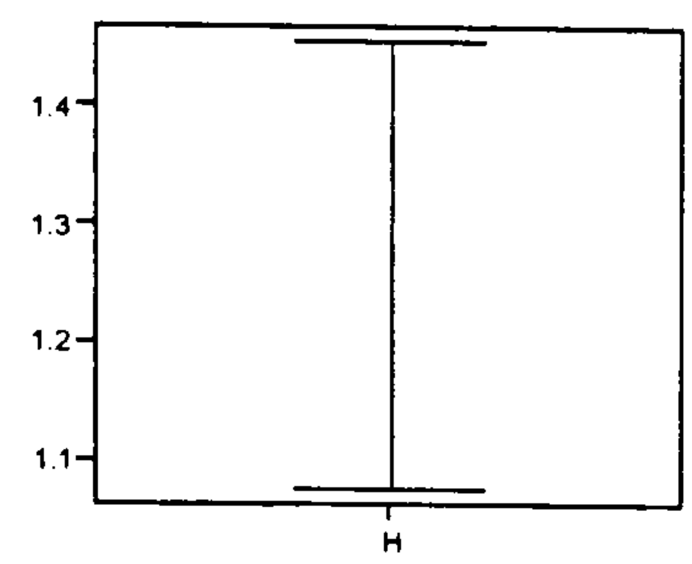
H = High, Moderate and Low

Figure K28
Number Of Documents Used

Task 1




Task 2




Task 3

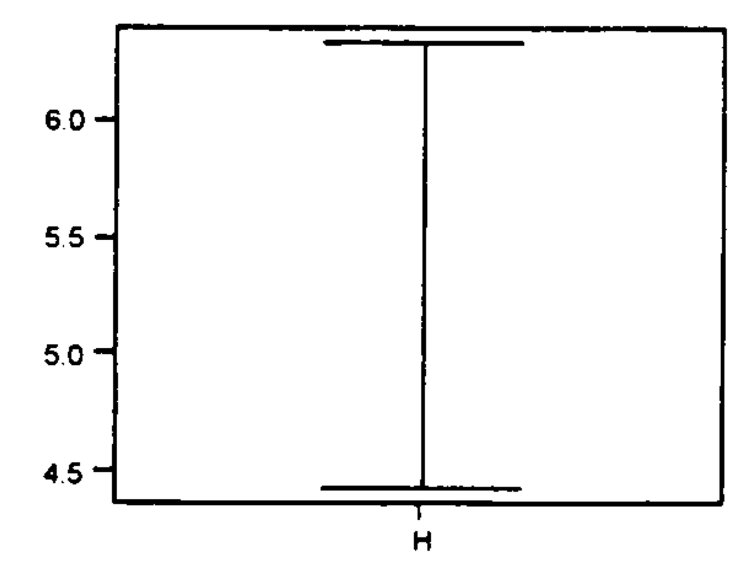
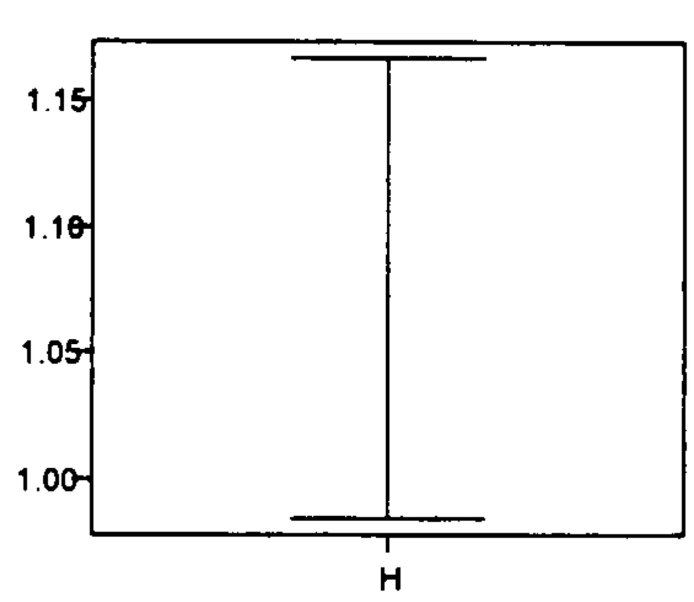
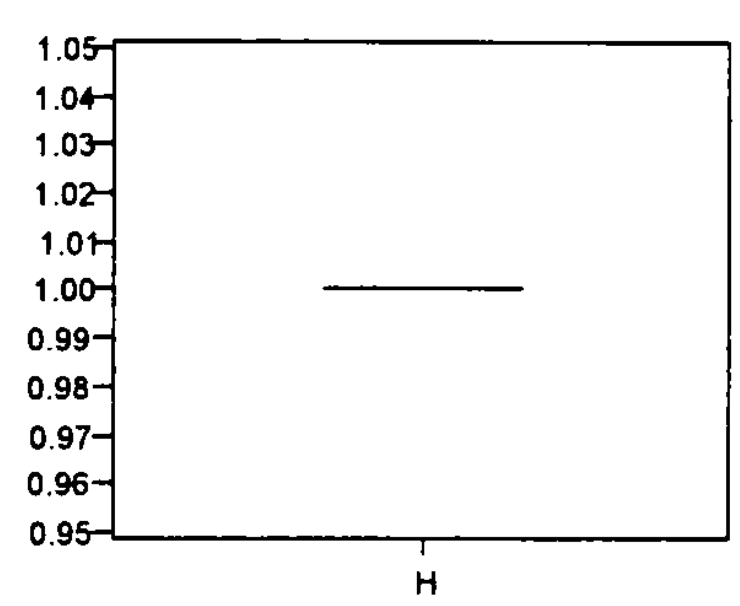



Figure K29
Number Of Document Types Used

Task 1




Task 2




Task 3

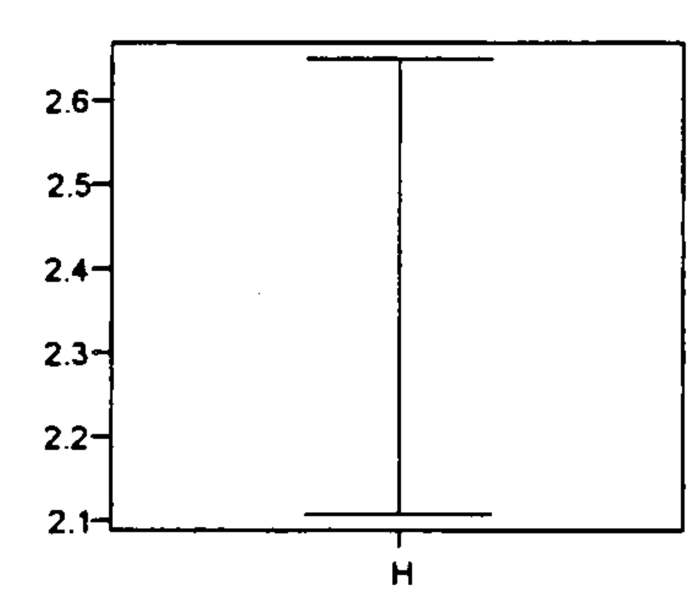
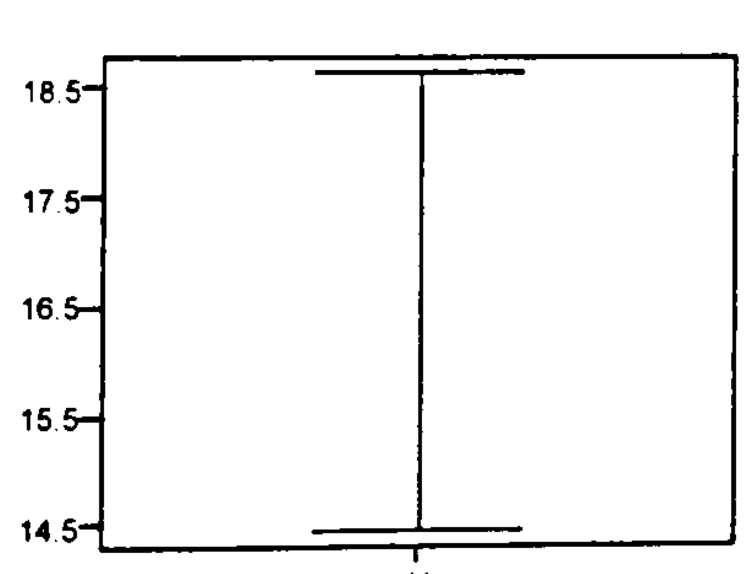
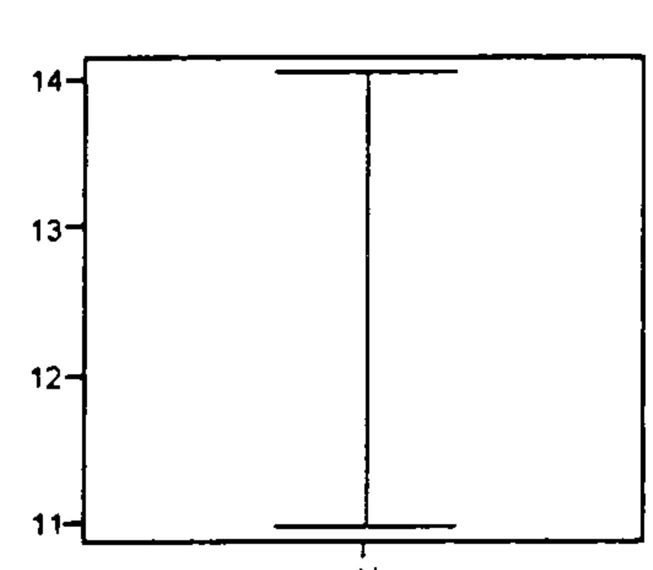



Figure K30
Number And Nature Of Operational Facilities Used

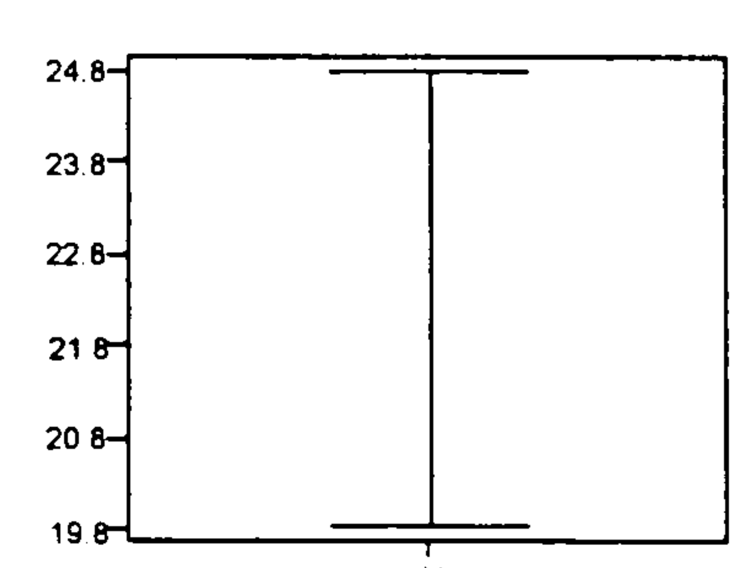
Task 1




Task 2




Task 3



## K.11 Combined Groups: Computer Literacy

In each of Figures K31, K32 and K33, the following key applies:

H = High; M = Moderate and Low

Figure K31
Number Of Documents Used

Task 1 Task 2 Task 3

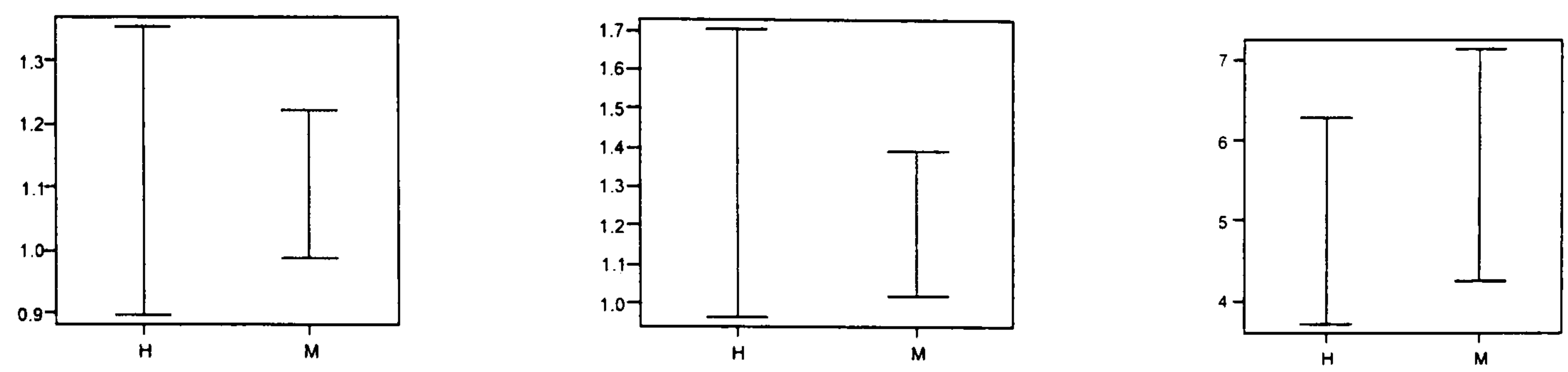



Figure K32
Number Of Document Types Used

Task 1 Task 2 Task 3

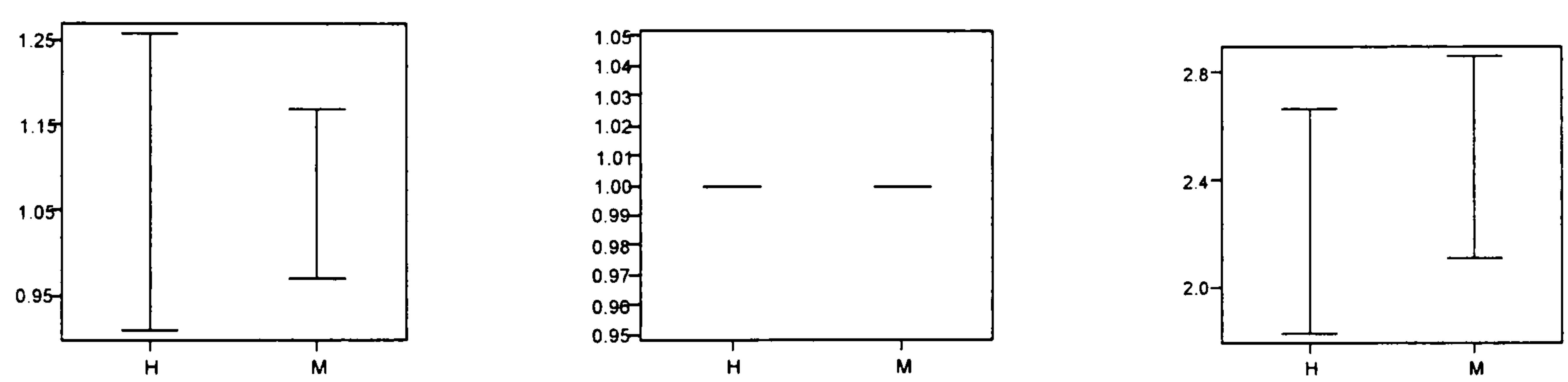
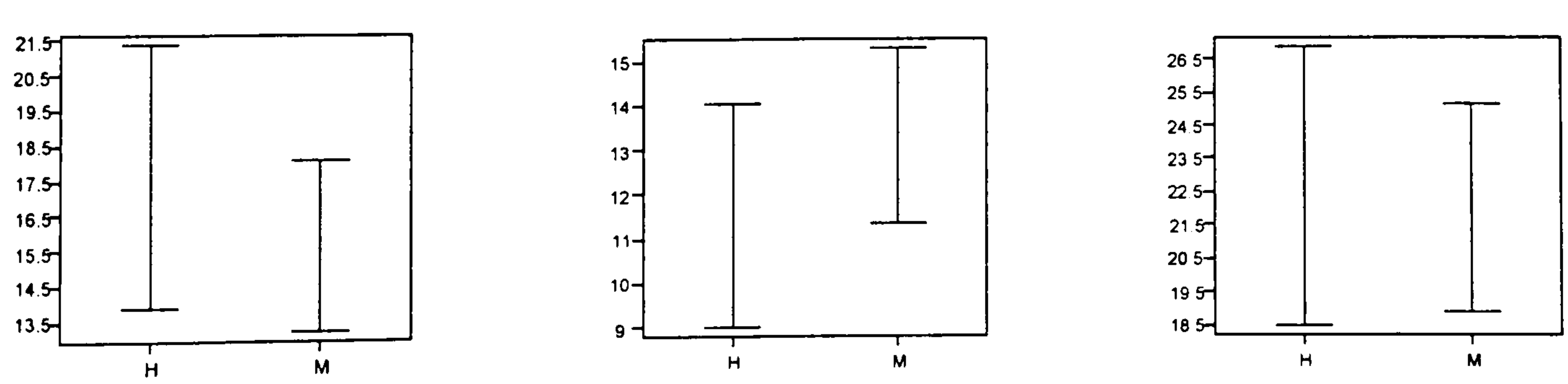



Figure K33
Number And Nature Of Operational Facilities Used

Task 1 Task 2 Task 3



## K.12 Combined Groups: Search Experience

In each of Figures K34, K35 and K36, the following key applies:

H = High; M = Moderate and Low

Figure K34
Number Of Documents Used

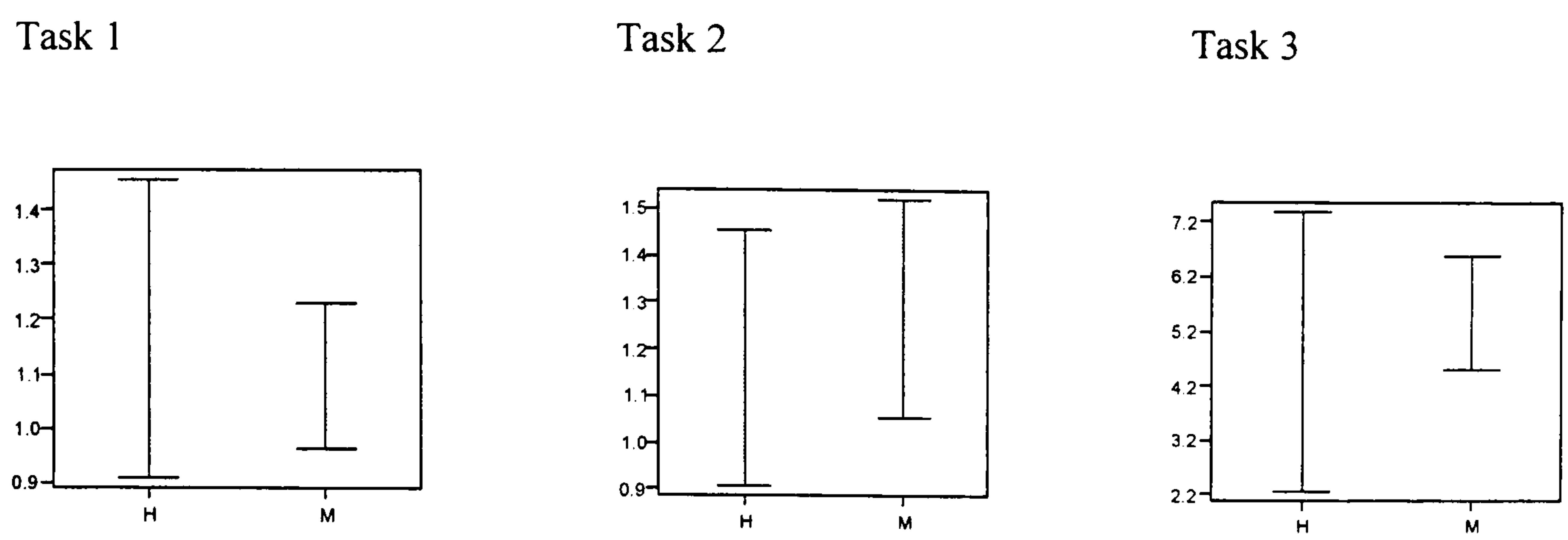



Figure K35
Number Of Document Types Used

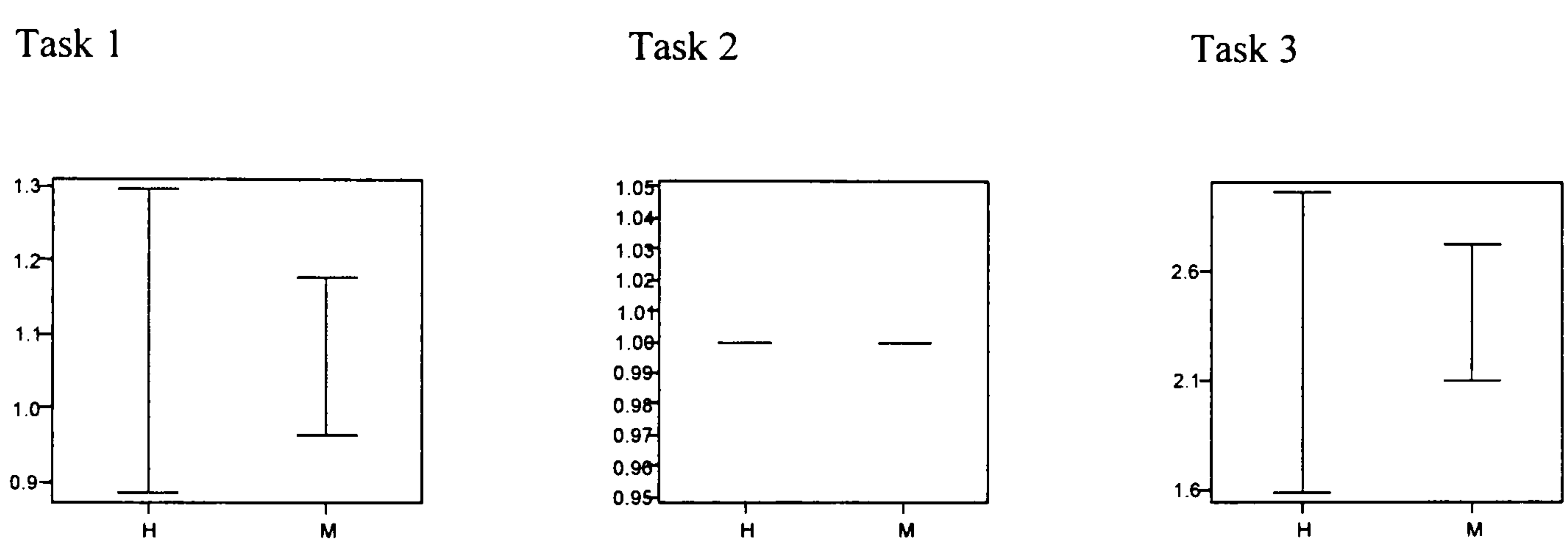
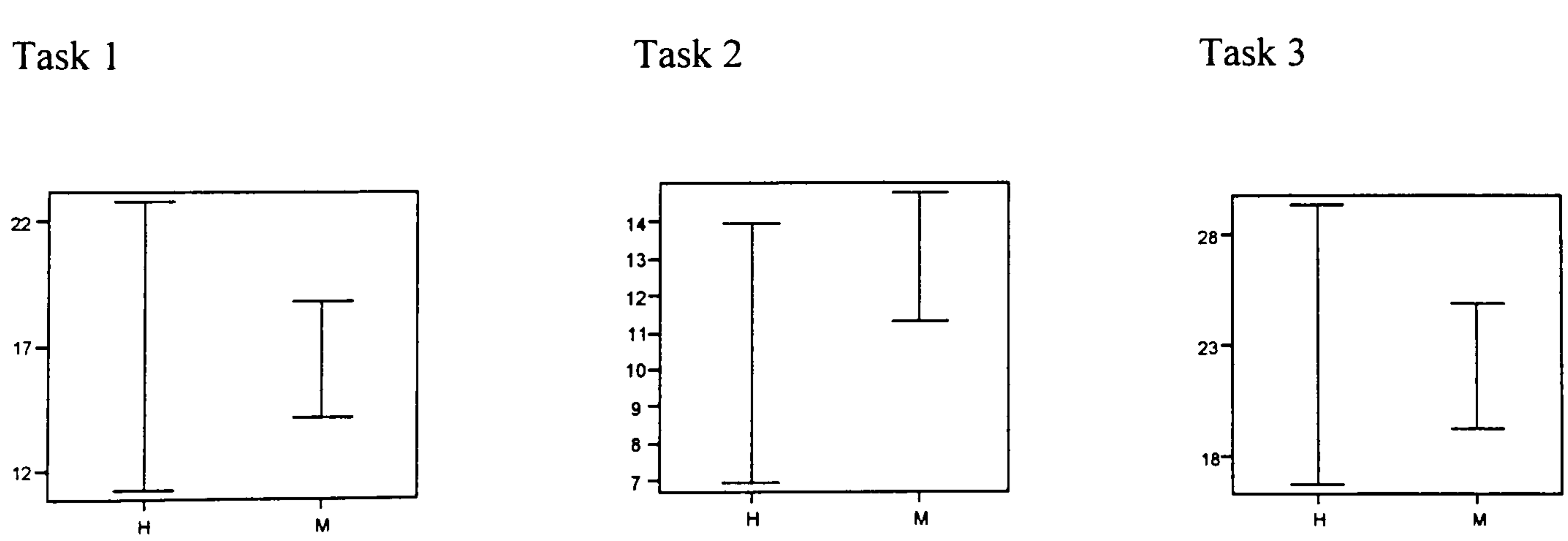


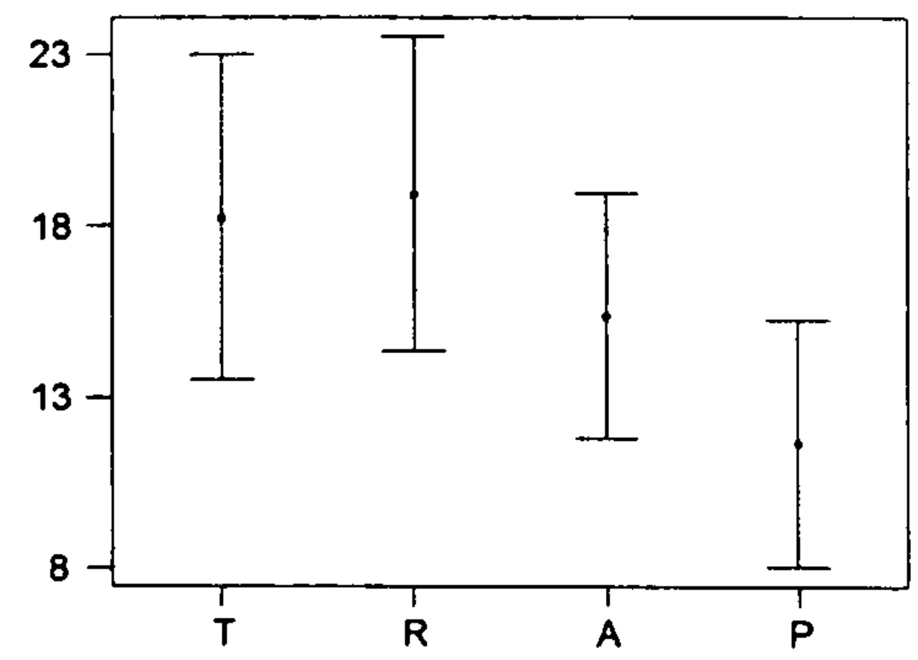

Figure K36
Number And Nature Of Operational Facilities Used



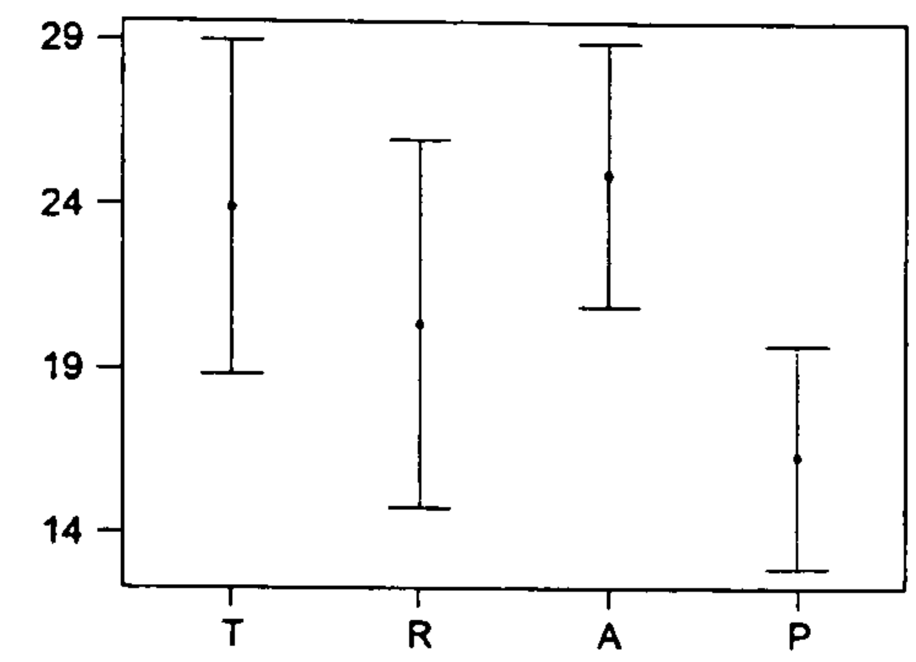
## K.13 Confidence Intervals For The Number and Nature Of Operational Facilities Used When Considering ELINOR System Defects

Figure K37
Learning Style

Task 1




Task 3

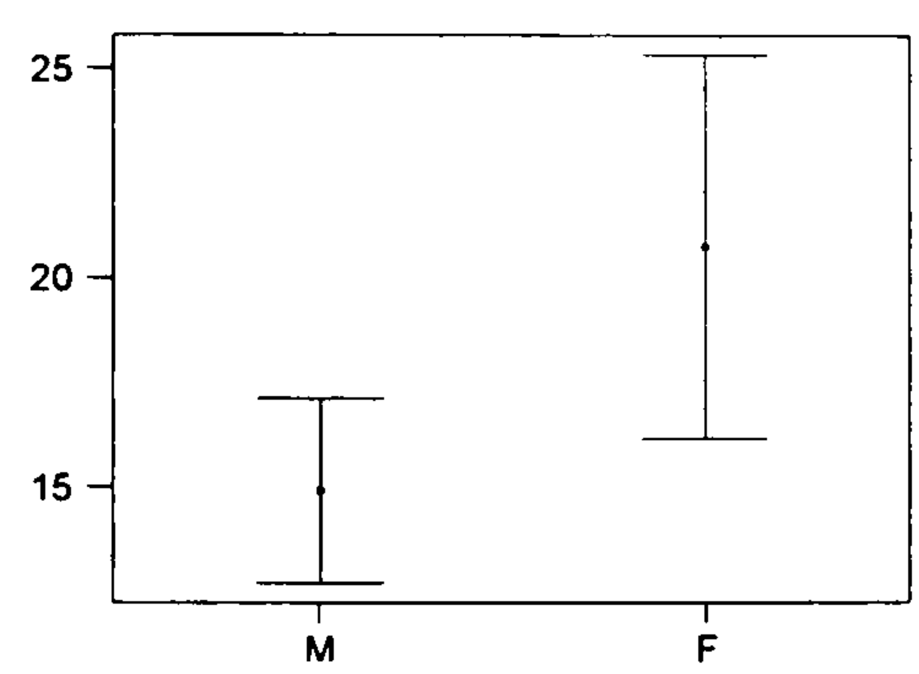



Key:

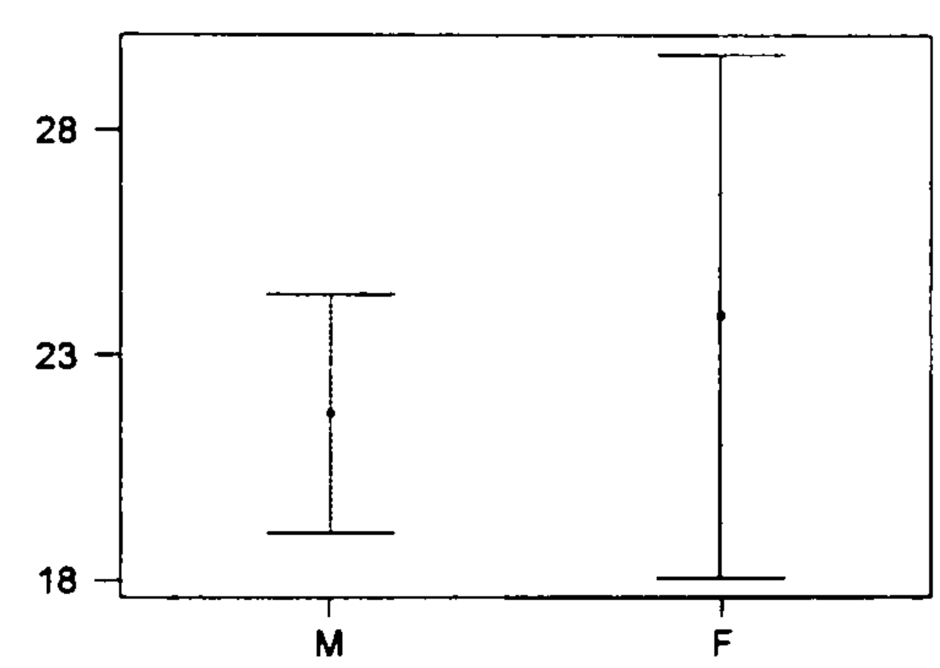
T = Theorists
R = Reflectors
A = Activists
P = Pragmatists

Figure K38
Gender

Task 1




Task 3

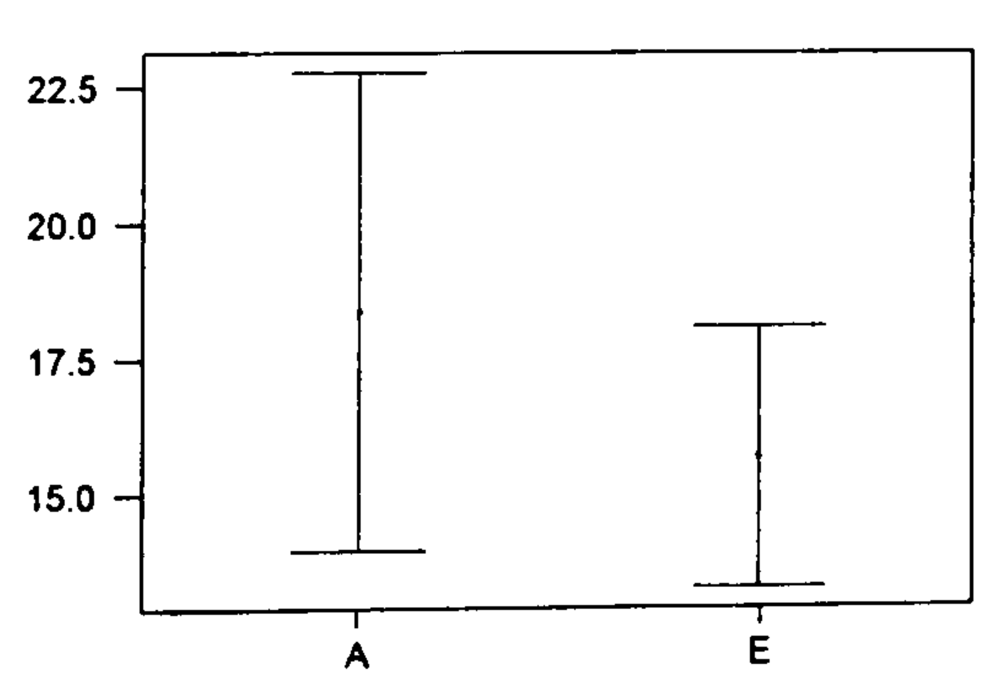



Key:

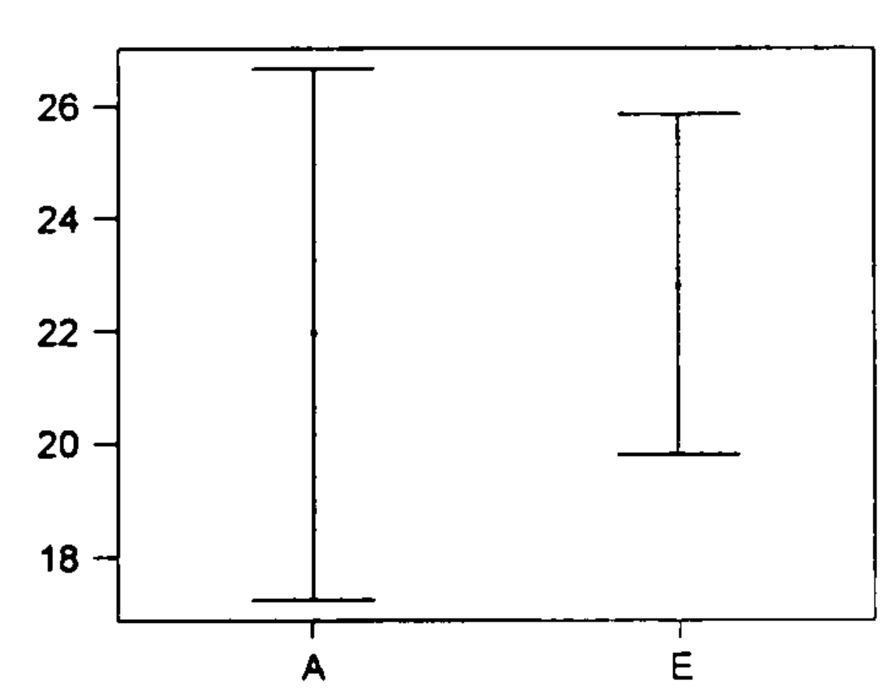
M = Males
F = Females

Figure K39
Ethnic Origin: Excluding Groups With Low Membership

Task 1




Task 3

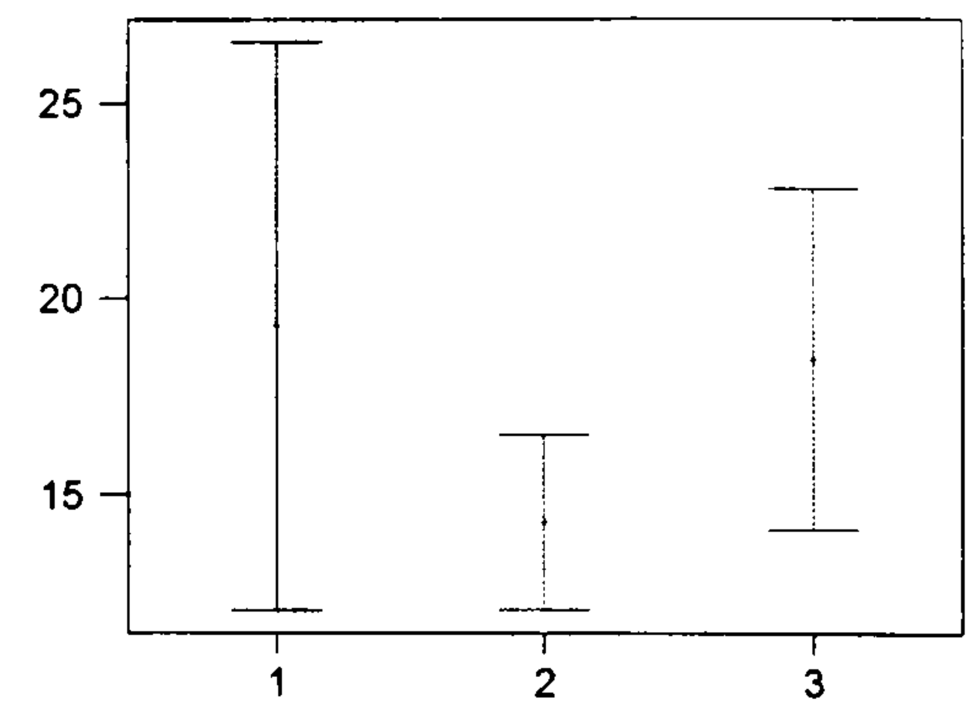



Key:

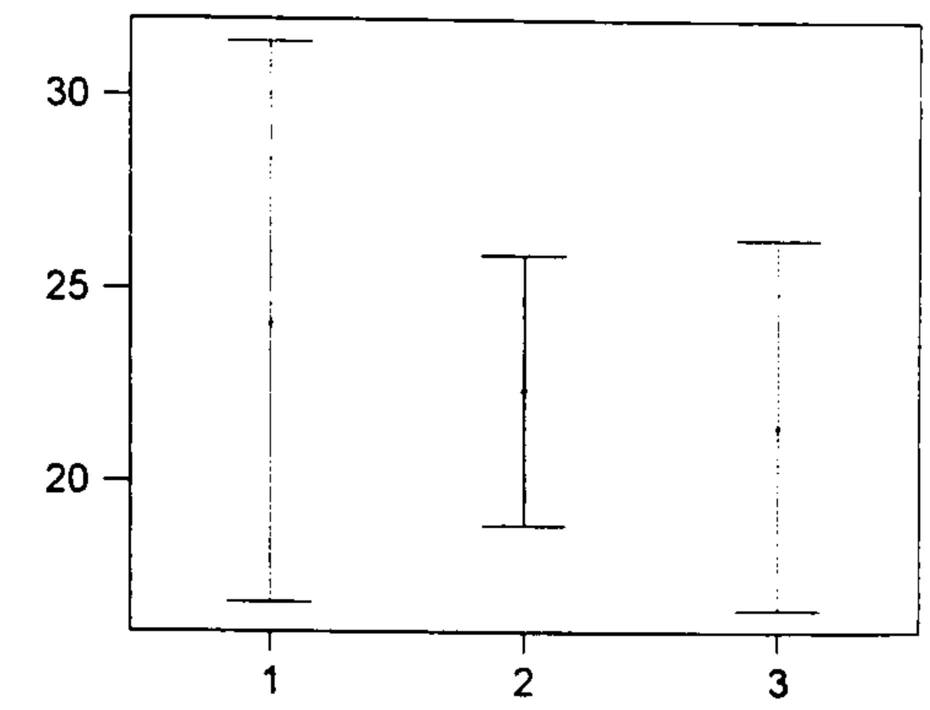
A = Asians
E = Europeans

Figure K40
Social Class: Excluding Groups With Low Membership

Task 1




Task 3

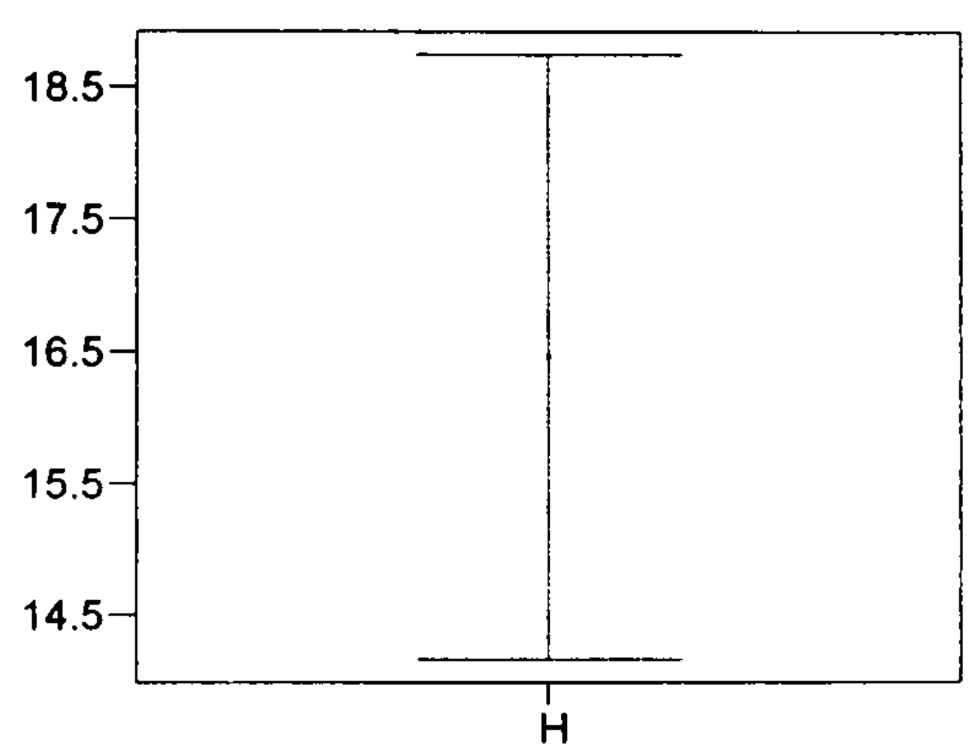



Key:

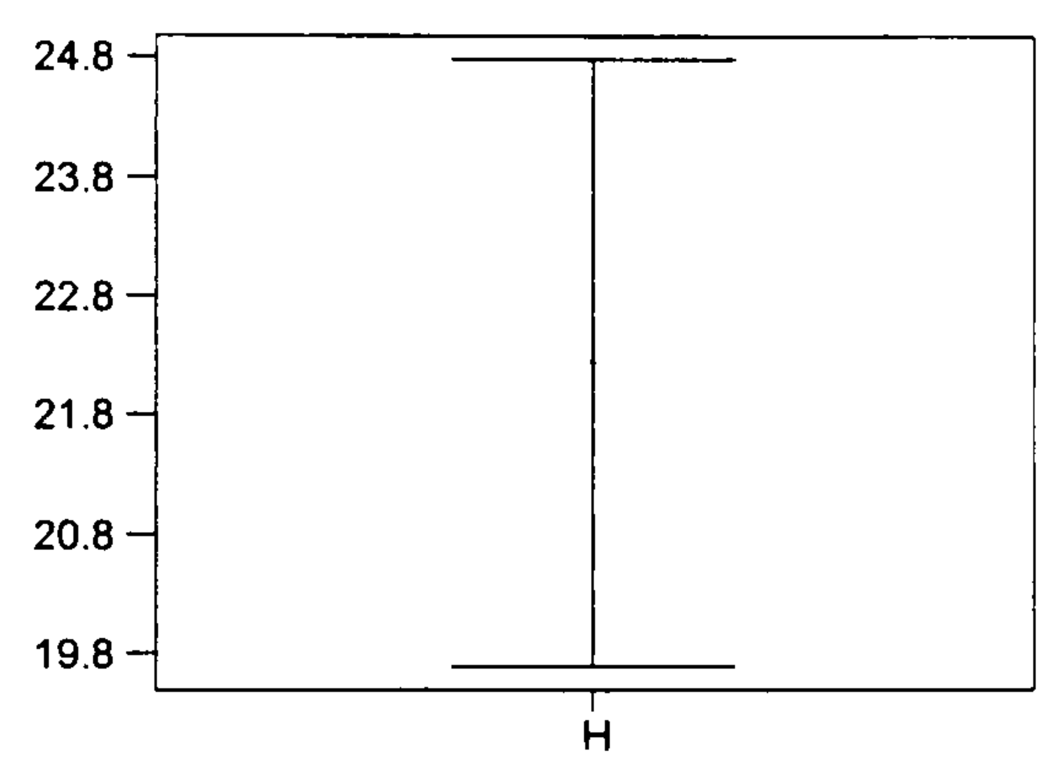
In Figure K37, the confidence intervals for social classes 1, 2 and 3 are represented by the corresponding number.

Figure K41
Computer Affinity: Excluding Groups With Low Membership

Task 1




Task 3

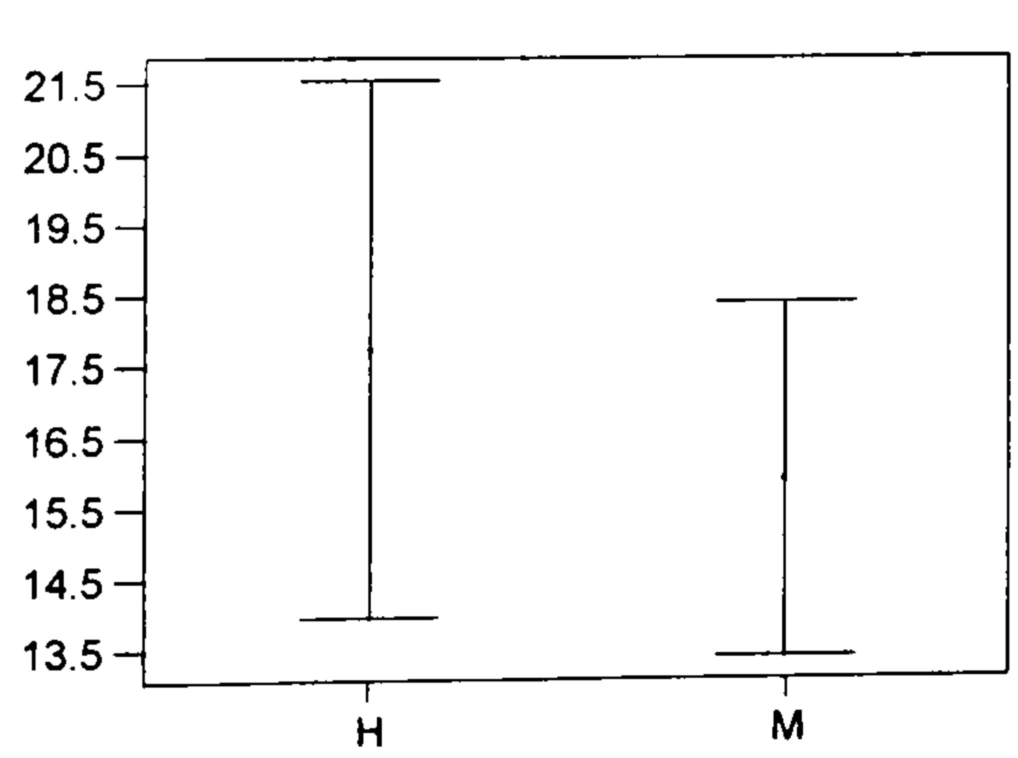



Key:

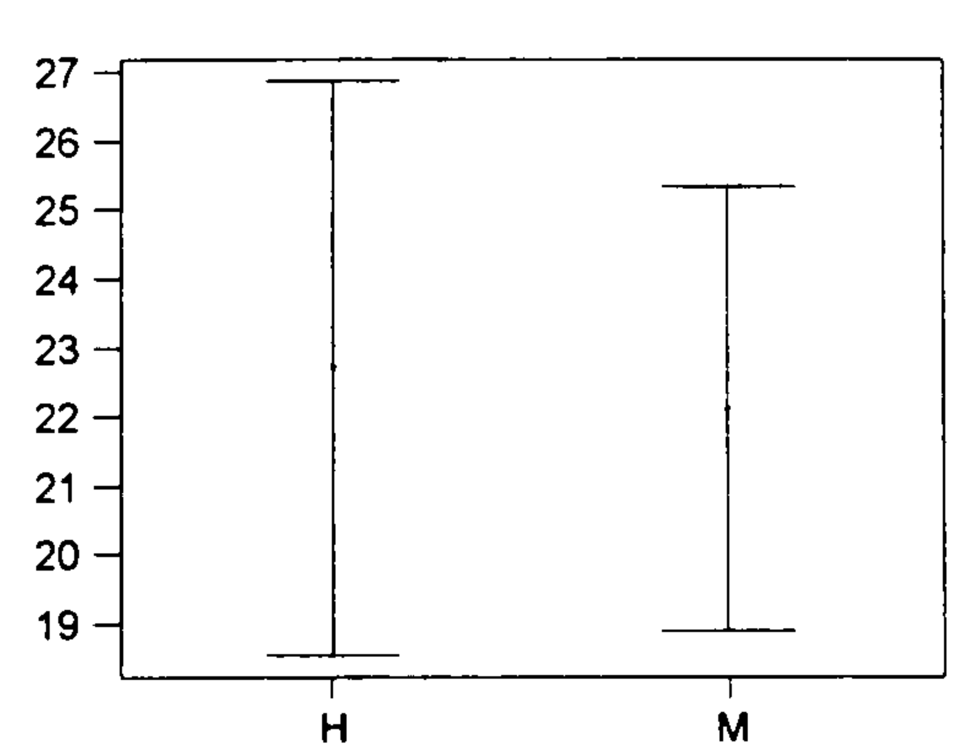
H = High

Figure K42
Computer Literacy: Excluding Groups With Low Membership

Task 1




Task 3

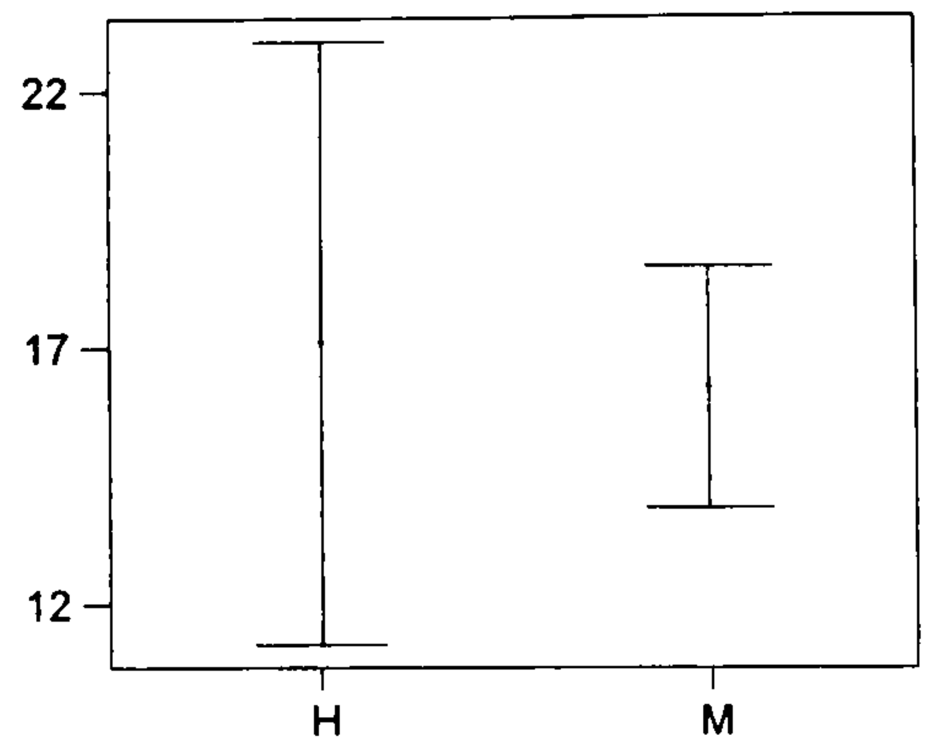



Key:

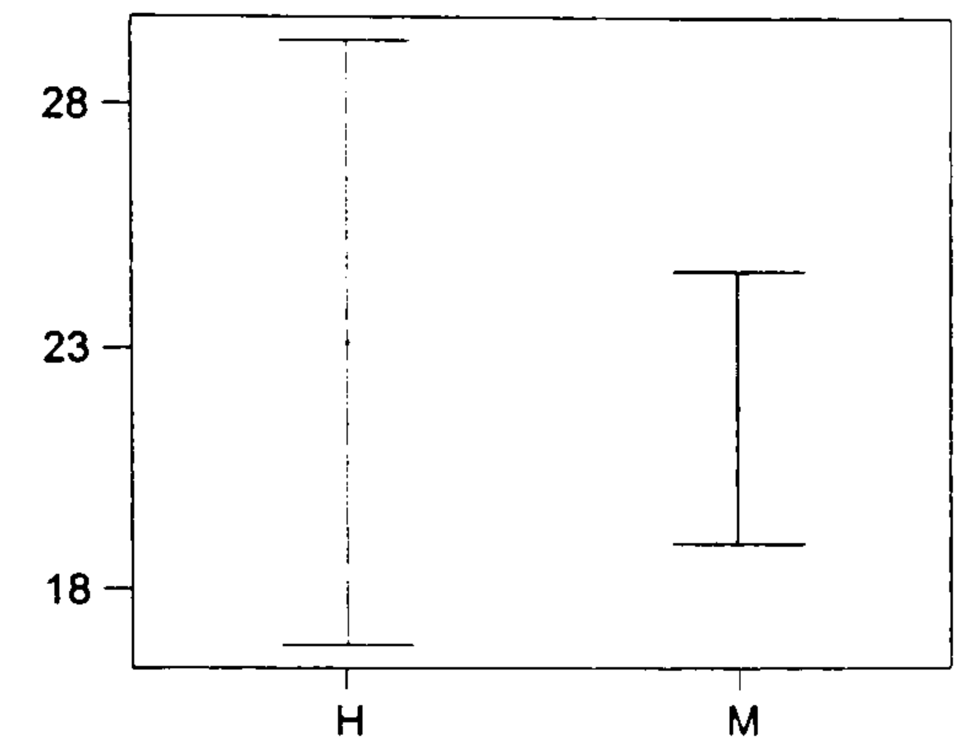
H = High
M = Moderate

Figure K43
Search Experience: Excluding Groups With Low Membership

Task 1




Task 3

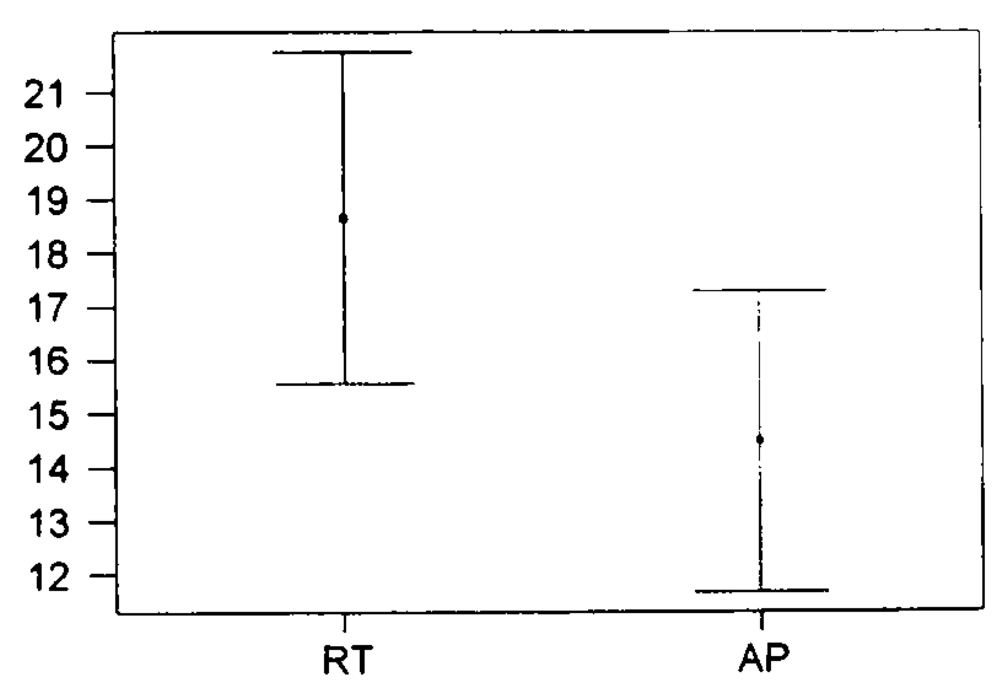



Key:

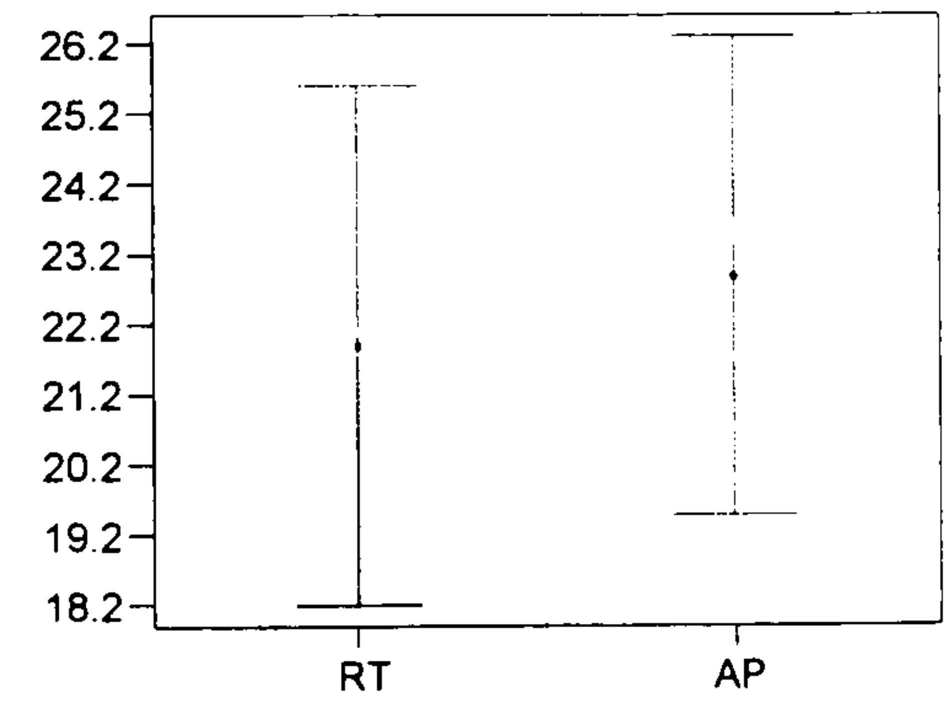
H = High
M = Moderate

Figure K44
Learning Style: Combined Groups

Task 1




Task 3

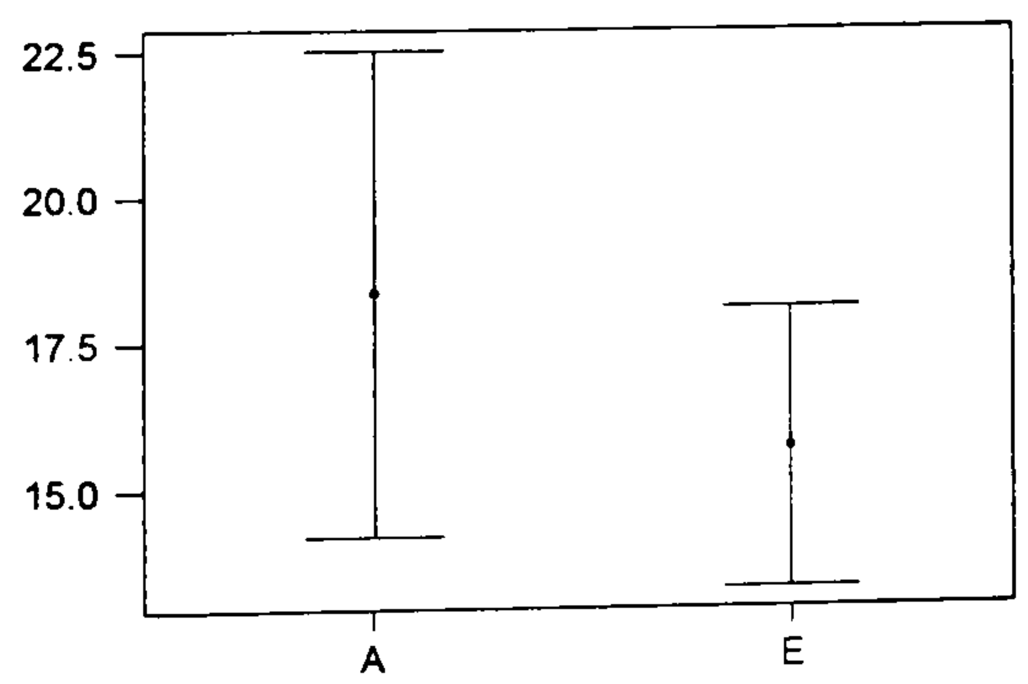



Key:

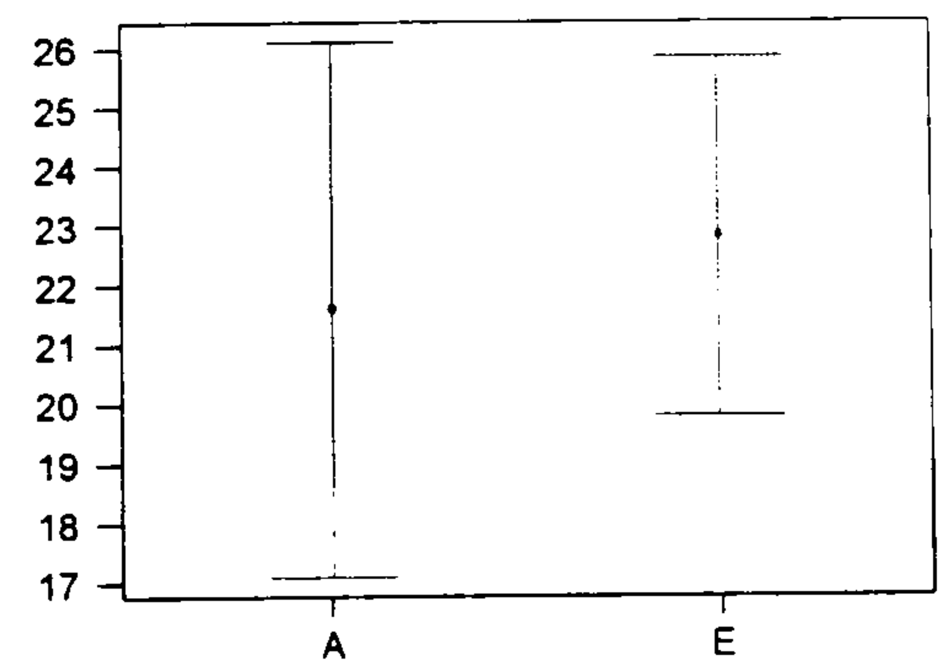
T = Theorists
R = Reflectors
A = Activists
P = Pragmatists

Figure K45
Ethnic Origin: Combined Groups

Task 1




Task 3

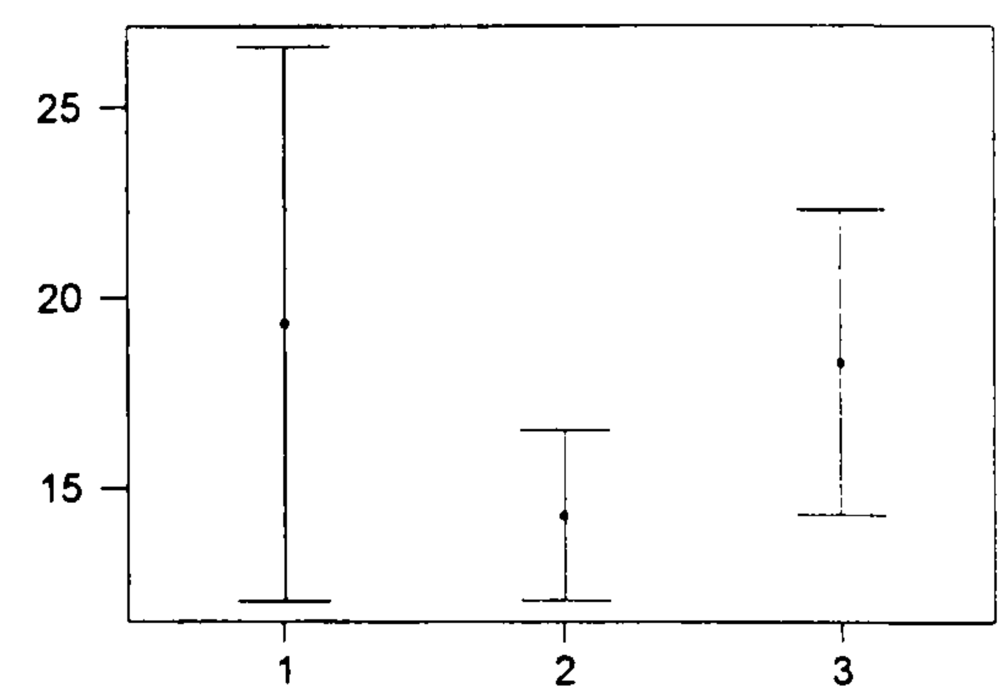



Key:

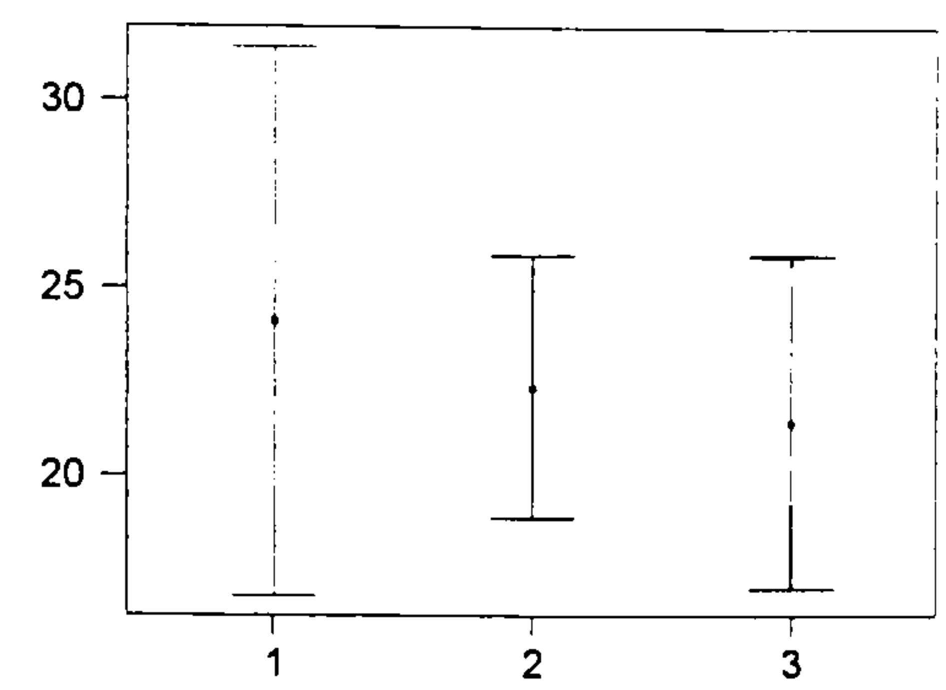
A = Asians and Africans
E = Europeans

Figure K46
Social Class: Combined Groups

Task 1




Task 3

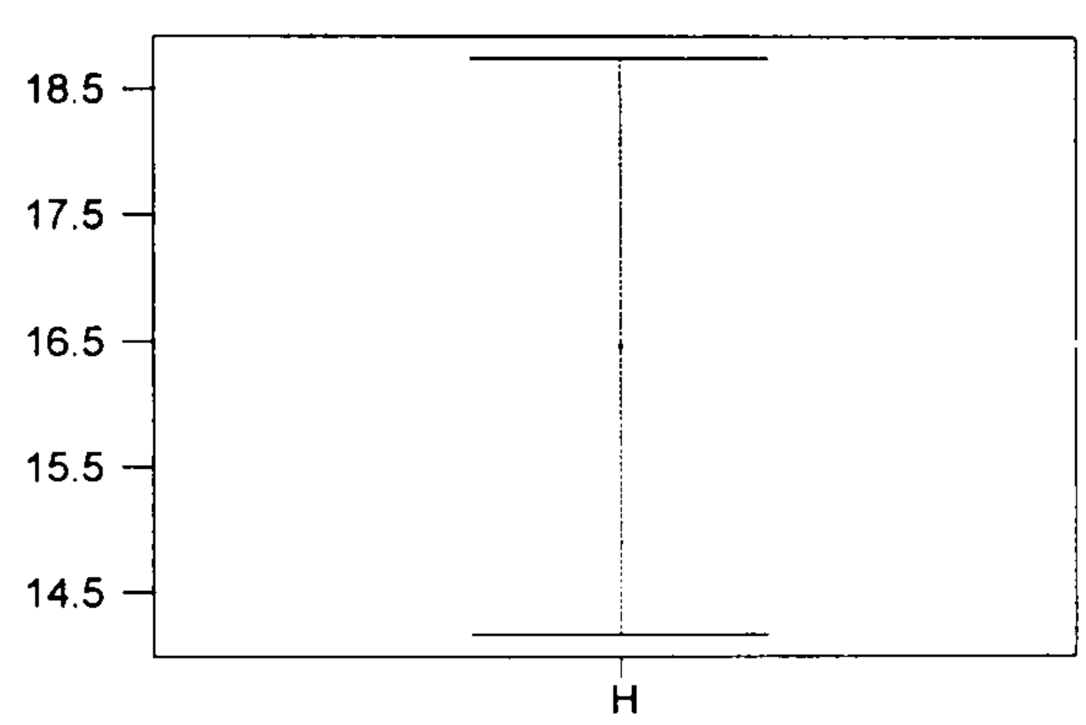



Key:

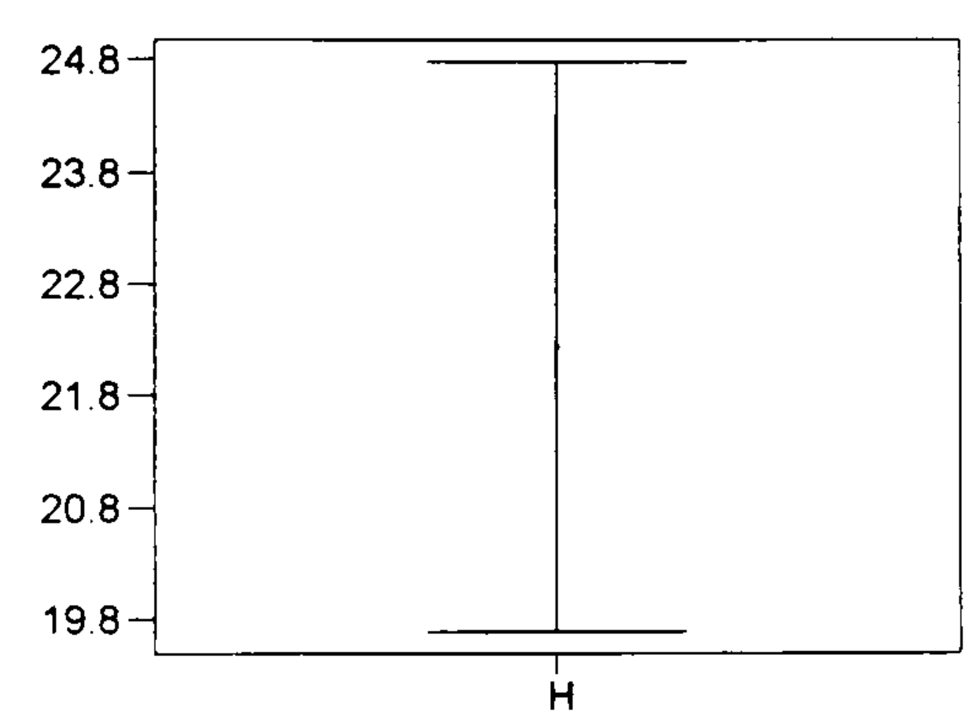
In Figure K37,
1 = Social class 1
2 = Social class 2
and
3 = Social classes 3 and 4

Figure K47
Computer Affinity: Combined Groups

Task 1




Task 3

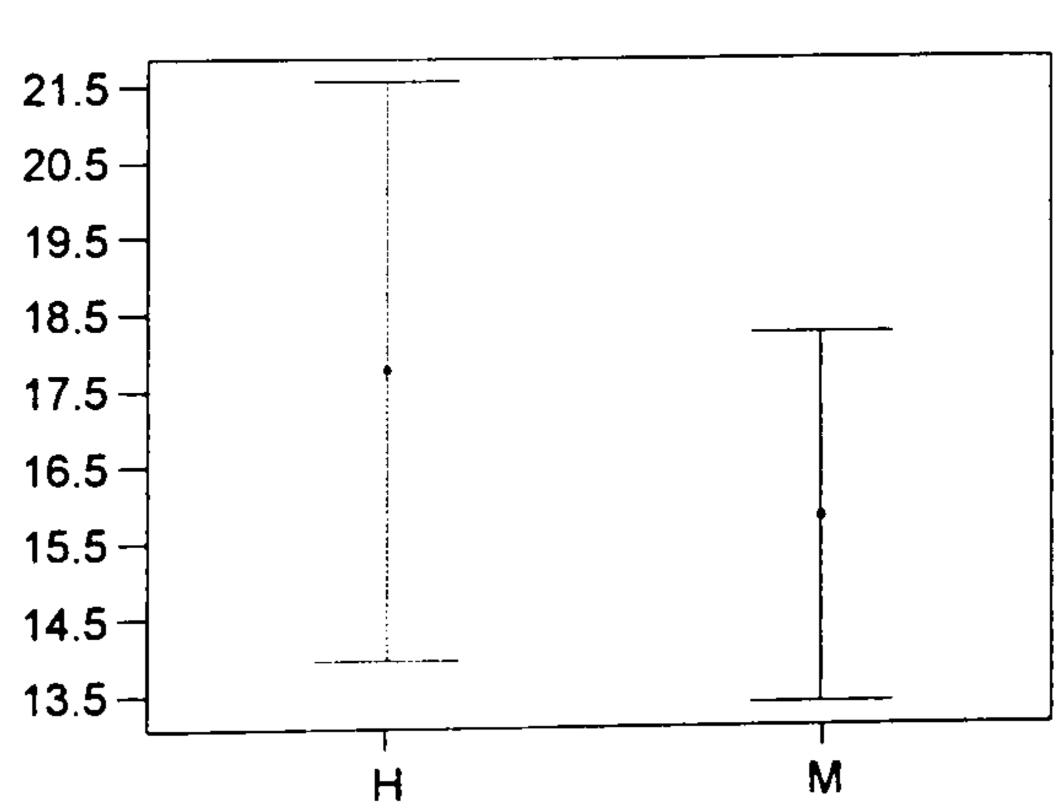



Key:

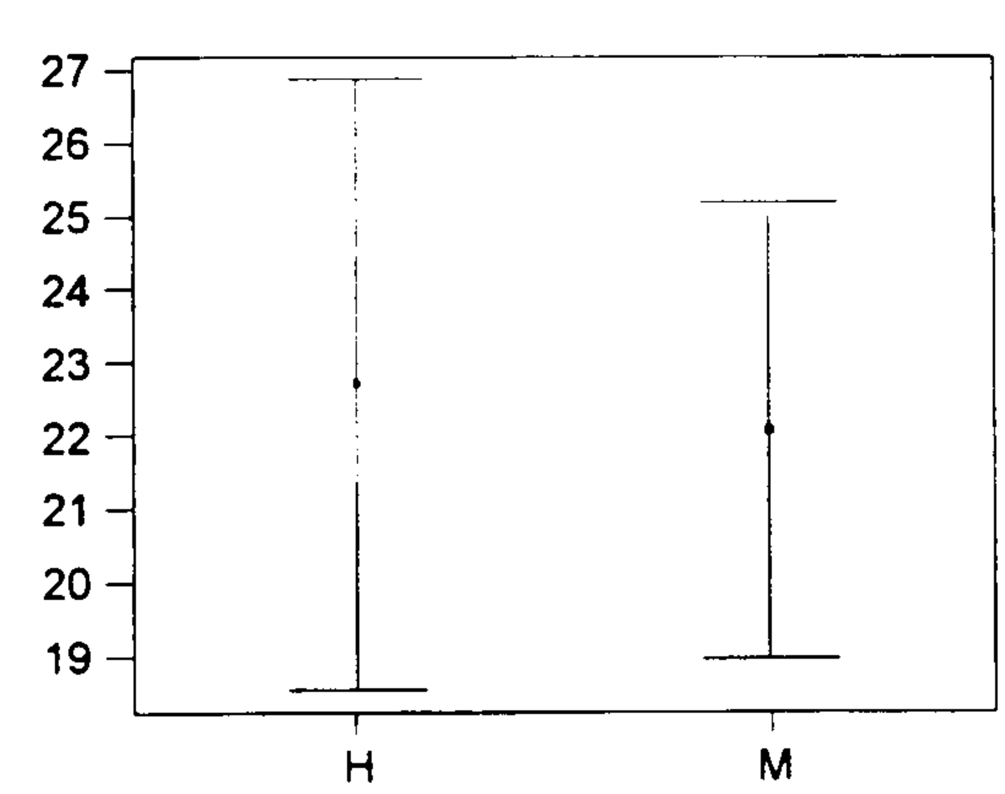
H = High, Moderate and Low

Figure K48
Computer Literacy: Combined Groups

Task 1




Task 3

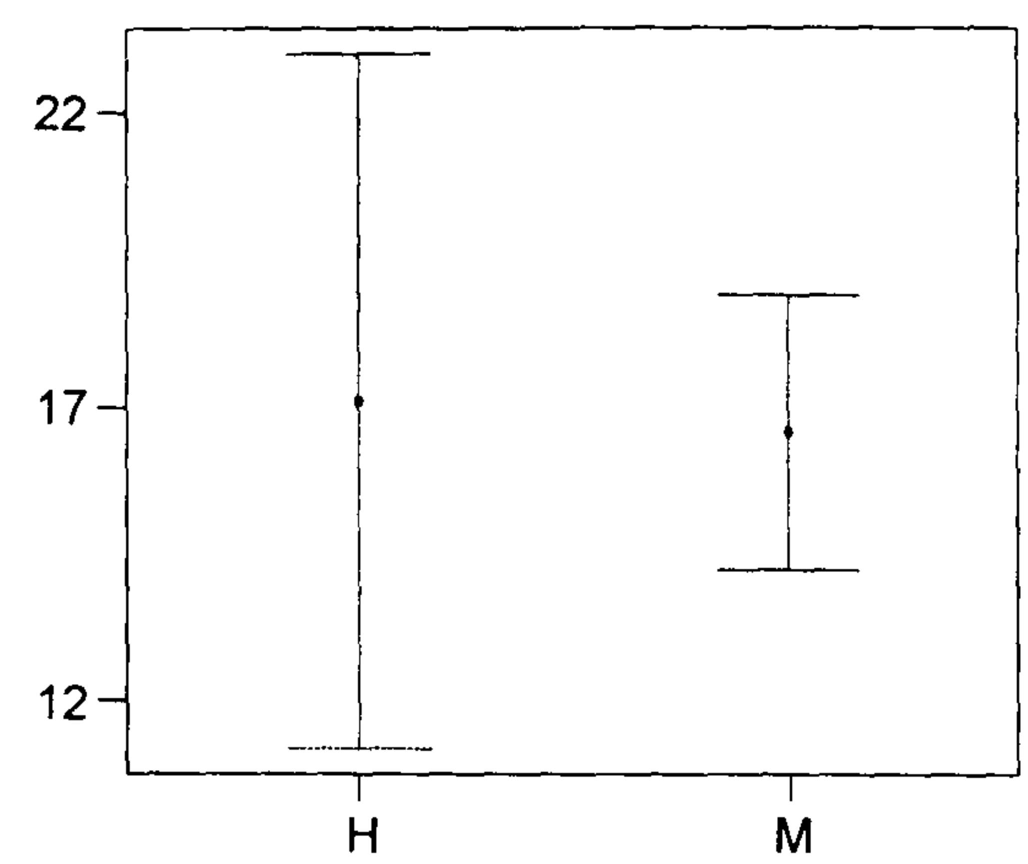



Key:

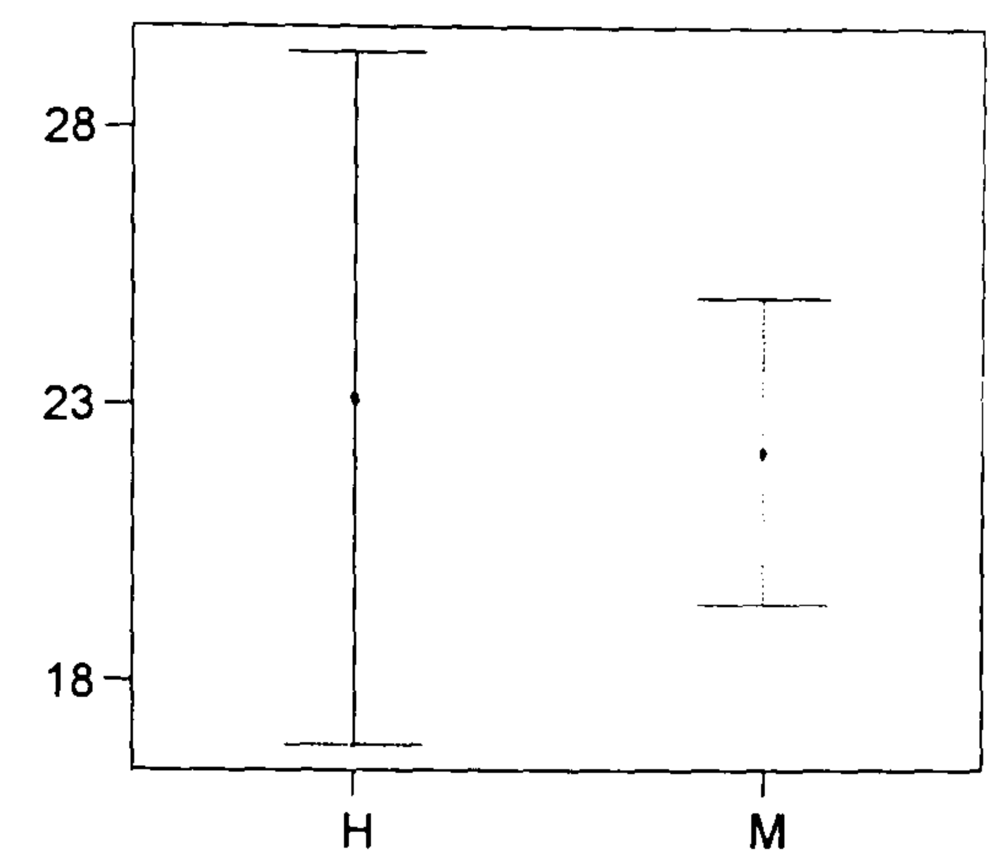
H = High
M = Moderate and Low

Figure K49
Search Experience: Combined Groups

Task 1




Task 3




Key:

H = High
M = Moderate and Low

# APPENDIX L

## Frequency Of Use: CD ROM, Database Packages And OPAC

Table L1
Frequency of Use: CD ROM

| | *Always* | *Sometimes* | *Rarely* | *Never* |
|---|---|---|---|---|
| *Learning Style* | % | % | % | % |
| Activists | 21.1 | 42.1 | 21.1 | 15.8 |
| Reflectors | 25.0 | 50.0 | 18.8 | 6.3 |
| Theorists | 25.0 | 33.3 | 41.7 | 0 |
| Pragmatists | 0 | 50.0 | 33.3 | 16.7 |

Table L2
Frequency of Use: Database Packages

| | *Always* | *Sometimes* | *Rarely* | *Never* |
|---|---|---|---|---|
| *Learning Style* | % | % | % | % |
| Activists | 21.1 | 31.6 | 36.8 | 10.5 |
| Reflectors | 37.5 | 50.0 | 6.3 | 6.3 |
| Theorists | 16.7 | 66.7 | 16.7 | 0 |
| Pragmatists | 0 | 66.7 | 33.3 | 0 |

Table L3
Frequency of Use: OPAC

| | *Always* | *Sometimes* | *Rarely* | *Never* |
|---|---|---|---|---|
| *Learning Style* | % | % | % | % |
| Activists | 0 | 47.4 | 26.3 | 26.3 |
| Reflectors | 12.5 | 50.0 | 12.5 | 25.0 |
| Theorists | 16.7 | 41.7 | 8.3 | 33.3 |
| Pragmatists | 0 | 33.3 | 33.3 | 33.3 |

# APPENDIX M

## Preferences For Greater And Fewer Documents

Table M1
Number Of Students In Each Learning Style Group Preferring More Of Each Document Type

Key: A = Activists R = Reflectors T = Theorists P = Pragmatists

| | Task 1 | | | | Task 2 | | | | Task 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | R | T | P | A | R | T | P | A | R | T | P |
| Books | 7 | 1 | 2 | 2 | 4 | - | 1 | - | 8 | 4 | 2 | 2 |
| Course Material : | | | | | | | | | | | | |
| Exam Papers | 5 | - | - | 1 | 7 | 2 | 5 | 3 | 2 | - | - | - |
| Handbooks | 2 | - | 1 | 1 | 2 | 1 | - | - | 4 | - | - | - |
| Lecture Notes | 7 | - | 1 | 1 | 5 | 1 | 1 | 1 | 9 | 2 | 1 | - |
| Study Guides | 4 | - | - | 1 | 4 | 1 | 1 | - | 4 | - | - | - |
| Syllabi | 3 | - | - | 1 | 2 | 1 | - | 1 | 4 | - | - | - |
| Journals | 5 | - | 3 | 1 | 1 | - | - | 1 | 4 | 4 | 3 | 1 |
| Library In-house Collection | 3 | - | - | 1 | 1 | - | 1 | - | 2 | 2 | 1 | - |
| Staff Publications | 2 | - | 1 | 1 | 2 | - | 1 | - | 4 | 1 | 3 | - |
| Student Project Reports | 3 | 1 | - | 1 | 1 | - | - | 2 | 4 | 2 | 1 | 1 |

Table M2
Number Of Students In Each Learning Style Group Preferring Fewer Of Each Document Type

Key: A = Activists R = Reflectors T = Theorists P = Pragmatists

| | Task 1 | | | | Task 2 | | | | Task 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | A | R | T | P | A | R | T | P | A | R | T | P |
| Books | - | - | - | - | - | - | 1 | - | 3 | - | 1 | - |
| Course Material : | | | | | | | | | | | | - |
| Exam Papers | - | - | 2 | - | - | 1 | - | - | 4 | 1 | 1 | - |
| Handbooks | 1 | - | 1 | - | - | - | 1 | - | 2 | 1 | 3 | - |
| Lecture Notes | - | - | 1 | - | - | - | 1 | - | - | 1 | 2 | - |
| Study Guides | - | - | 1 | - | - | - | 2 | - | 1 | 1 | 3 | - |
| Syllabi | - | - | 2 | - | - | - | 1 | 1 | - | 2 | 2 | 1 |
| Journals | - | 1 | - | - | - | - | 1 | - | 1 | - | 1 | - |
| Library In-house Collection | - | - | 1 | - | - | - | 1 | - | - | - | 2 | - |
| Staff Publications | 1 | - | - | - | - | - | 1 | - | - | - | 2 | - |
| Student Project Reports | 1 | - | 1 | - | 1 | - | 1 | - | 3 | - | 2 | - |